UNIVERSITY OF EDUCATION, WINNEBA

FOREST COVER CHANGE ANALYSIS: THE ESTABLISHMENT OF PLANTATION FOREST BY LOCAL FARMERS IN OFFINSO NORTH DISTRICT

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DECLARATION

STUDENT'S DECLARATION

I, **Rhoda Dedaa Acheampong**, declare that this Thesis / Dissertation / Project, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

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SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Thesis / Dissertation / Project as laid down by the University of Education, Winneba.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ACRONYMS

CBF	Community Based Forestry
CBFMP	Community-Based Forestry Management Programme
CCFI	Collaborative Community Forestry Initiative
CF	Community Forest
CFM	Collaborative Forest Management
CO_2	Carbon dioxide
FAO	Food and Agriculture Organization
FRA	Forest Resources Assessment
LULC	Land-Use/Land Cover
MTS	Modified Taungya System
NFPDP	National Forest Plantation Development Programme
NGO	Non-Governmental Organisation
NTFPs	Non-timber forest products
PADO	Private Afforestation Developers Organization
RRI	Rights and Resource Initiative
SDGs	Sustainable Development Goals

ABSTRACT

Deforestation has been on the rise in worlds' tropical forest from the late 20th century. Africa has lost more than 19 million ha of its forest. However, Ghana recorded a net gain of 1.96% in forest cover in 2018. This study assessed the role of plantation forest in the forest cover change of Offinso North District. The specific objectives were to assess what intrigued farmers in establishing forest, its extent, benefits and challenges. The study used the mixed method approach. It employed the purposive and systematic sampling methods. A sample of 135 farmers was used. Data was collected through semi – structured interviews and observation. GIS and Remote Sensing were used to assess forest cover change from 1990 – 2020.The study revealed that plantation forest was established by farmers mainly for economic benefits. The study showed that all farmers planted Teak with their alternate livelihood activities as food and cash crop farming. From this study, plantation forest increased by 4.3% and 18.5% in 1990 – 2015 and 2015 – 2020 respectively. Also, the study revealed that a change in forest cover improves local farmer's socio-economic wellbeing. Moreover, farmers' main challenges were no assistance from government and low income obtained from tree printing. It is recommended that the government should intervene in setting prices of trees planted by farmers together with assisting them with financial and technical support.

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Forestry is not only about trees but also the people to whom the trees play major role in solving their needs (Westoby, 1987 as cited in FAO, 2006). Forests play significant role in the livelihoods of the forest fringes communities and the nation at large through foreign exchange, tourism, raw materials for industries and as a means of employment. The main occupation of the forest fringe communities in the developing countries is agriculture, mostly food crop farming. This has contributed to the rise in the depletion of forest in recent times (Osei-Mainoo, 2012). The depletion occurs frequently in state owned forests as compared to private owned ones since such people recognized public-owned resources as belonging to 'no one', therefore it is characterized with limited management. Also, the direct forest users (those dependent on forest resources) are neglected in taking decision and participating in forest management.

Globally, environmental degradation and deforestation have been an area of study to fight the changes in climatic phenomena over the years but its focus now have been shifted more to the developing countries (Allen & Barnes, 2017).This is because majority of the citizens in these countries heavily rely on forest as a main source of livelihood. Human being's reliance on forest resources bring forth the need to put down strategies to encourage the act of sustaining forest resources. Forest resources are non-excludable to a considerable extent hence the planting of trees should not be a matter of choice but a necessity to support life now and in future. The attitude of strong sustainability should be adopted to ensure a perpetual flow of the forest resources. Over the years, there has been a shift in terms of forest management from the centralized to

the decentralized management which now involves communities and smallholders in managing and governing forest. Individual contribution to forest cover in the form of tree planting is considered as a form of community forestry. Community forestry therefore shows the relation among people's activities, forest and forest products (National Community Forestry Center, 2000). It is hypothetical that peoples' participation in forest governance with their own lands brings about an effective sustainable forest management and a reduction in poverty in forest fringes communities.

Hardin (1968) related community forest management to "the tragedy of the commons", where as a result of ownership of resources not being clarified, people extract resources (they see as common) excessively without replacing them due to free access resulting from low management. This then leads to a tragedy such as loss of biodiversity, dying of water bodies, green house effects and change in weather patterns. There can be effective sustainable community management of forest resources when boundary of the resources can be identified and the changes in the resource condition are frequently monitored (Hardin, 1968). Afforestation and reforestation are classified under plantation forests. Afforestation is the process of planting trees on a barren land devoid of any trees to create a forest whereas reforestation employs specifically planting trees in forested areas that has decreasing number of trees. Individuals who establish plantation forest are often classified as private foresters. It is with this that led to the establishment of an association called Private Afforestation Developers Organisation (PADO) in Ghana in 2010.This association is made up of small-scale farmers and companies who plant trees both at the reserves and off-reserves. Community Forest Management (CFM) helps in attaining more efficient use of forest

resources which increases environmental sustainability. It is also a powerful tool for reducing poverty and inequality in developing countries.

1.2 Statement of the Problem

The population of trees and humans are supposed to be in an equilibrium for harmonious and a healthy living. Nevertheless, that of humans keep on exceeding that of trees as a result of deforestation and degradation. In the late 20th century, the government of Ghana became concerned with the accelerating rate of degradation, its effect on the environment and a failure of centralized forest management (Osei-Mainoo, 2012). This led to the introduction of forest decentralization by the government to involve local people to plant trees (Twery, 2004). Also, there was the implementation of the new Forest and Wildlife policy in 1994 with the aim to manage and sustain the country's forest and wildlife (Asare-Kissiedu, 2014). This brought forth various forest strategies such as Private plantation, Taungya System (TS), Modified Taungya System (MTS) and Solely Government system. However, according to Wilkie (2003) the country still records 2% rate of deforestation mostly in the forest reserves. As at 2010, the annual loss of forest cover in Ghana was 135, 395 ha (FAO, 2012). This is mainly as a result of farming, illegal logging and timber harvesting without replacing them also contribute to the rate of deforestation in Ghana (Acheampong, 2016).

Several studies have been conducted mostly in assessing people's contribution to tree planting on degraded portion in state's forest reserves. This is known as Modified Taungya System. Issues of tree planting and poverty mitigation have also been assessed. Ribot and Larson (2005) postulated that the most appropriate means of ensuring sustainable forest resources management is by involving local people at the forest fringes. However, little has been done on the role of the establishment of

plantation forest by local farmers with their own lands. It is with this gap that this study was designed to address.

1.3 Purpose of the Study

The study sought to investigate the extent of plantation forest that has been established by local farmers with their own lands in Offinso North District.

1.4 Objectives of the Study

The main objective of the study was to assess the role of the establishment of plantation forest by local farmers. This was achieved through the following:

1.4.1 Specific objectives were to:

- Investigate what intrigue local famers to establish plantation forest in Offinso North district.
- Assess the extent of plantation forest established in the study area.
- Assess the benefits, obtained from plantation forest established in the study area.
- Examine the challenges local farmer's encounter in establishing plantation forest in the study area.

1.5 Research Questions

- Why do local farmers establish plantation forest in the study area?
- What is the total area of the established plantation forest by local farmers in the study area?
- How has plantation forest affected the wellbeing of local farmers who practice it?
- What are the challenges faced by local farmers in establishing plantation forest in the study area?

1.6 Hypothesis

H_0 – A change in forest cover does not improve local farmer's socio-economic wellbeing

H_1 – A change in forest cover improves local farmers' socio-economic wellbeing

1.7 Significance of the Study

The study brings forth the extent of plantation forest established in the study area. It has added to the information to be used by the Ministry of Lands and Natural Resources in reclaiming degraded forested areas. The findings of the study will regulate the rate of deforestation and to keep track of the changes in the forest cover in the study area over time.

1.8 Scope of the Study

The study focused on assessing the change in forest cover over a period of thirty years (1990 – 2020) in selected communities in Offinso North District where local people has established plantation forest on their own lands. Such areas are demarcated as off reserves. The study also analysed the benefits and challenges farmers encounter in establishing plantation forest in the District.

1.9 Limitation of the study

Some of the farmers were not willing to respond so had to be taken out of the study. Due to the distance of their settlement, not all of the respondent's farm lands were covered.

1.10 Organization of the study

This study is in six main chapters. The first chapter is about the general introduction of the study, the problem statement, hypotheses, objectives of the study,

research questions and the limitations of the study. The second chapter reviews literature related to the study. This chapter gives detailed information about the historical and theoretical perspective of the study. Chapter three describes the research methodology, where the profile of the study area, methods and materials for data collection and how the data was analysed are discussed. The fourth and fifth chapters present and discuss the findings in relation to the objectives. The final chapter presents the major findings, conclusion and recommendations for this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The focus of this research is the establishment of plantation forest and its effects on the forest cover in the study area. The chapter analyses the history of forestry worldwide including Ghana. Literature on factors that influence local farmers in using their lands for tree planting was assessed. It further looked at the forest cover change analysis and the anthropogenic /natural activities that affect plantation forest. Also, the section brings to bear the significance and the challenges people encounter in tree plantation. The underpinning theories for the study are Socio-Ecological systems (SES) and the models for community forestry which emphasize on the support service model.

2.2 History of forestry in the world

Over 800 centuries, 46% of the world's primary forests (virgin forest that has not been disturbed) had been altered and only 22% remains in its original state (Mujuri, 2007).Between 1990 and 1995, South America lost 24 million ha of its forested areas followed by Africa with 19 million ha and then Asia of 17 million ha of forest area (Gadow, 2001). As at the 20th century, the total world's forest covered about 3.4 billion ha with the largest in South America (Gadow, 2001). Asia was the next continent with greater amount of the forested areas with Africa recording least of the forested areas. Out of this, the scope of plantation forest was about 135 million ha in 2000 and it increased to 140.5 million ha in 2005 (FAO, 2006; Kanowski, 1997). Greater portion of plantation forests were located in the tropics than the temperate regions (Kanowski, 1997). In the last decade of the 20th century, the total forest area of Africa depreciated by 52.6 million ha which amounted to 56% of the global loss (Nair &Tieguhong, 2004).

In 2005, the world's forest was estimated to be 4 billion ha corresponding to 0.62 ha per capita covering about 30% of the earth's total land (Mujuri, 2007). Thus, the plantation forest and natural forest regeneration increased in most portions of the earth. Plantation forests in Sub Saharan Africa was about 3 million ha as at the 20th century (Sharma ,Rietbergen& Heimo, 1994) and covered 90% of West Africa's forest (Onyekwelu &Yirdaw, 2006).By 2010, the world's forest further degraded by 130 million ha, however, it gained about 78 million ha mostly in plantation forest across the globe (FAO, 2012).

In addition, the high forest zone of Ghana was over 8.2 million ha but by the end of 20th century, it had declined drastically to about 1.8 million ha (Osumanu & Ayamga, 2017). In 2010, Ghana's natural forest was about 22% of its total land area where 13,700 ha of its mangroves had been degraded in that same year (Tufuor, 2012). He also estimated that the country's annual forest loss of 2.1% for 10 years (2000-2010) has recorded an annual loss of approximately 8,000 tons of carbon stock. It further reduced to 6,235,102.32 ha by 2012 (Forestry Commission, 2019). According to the forest data report, the forest cover as at 2018 had increased to 6,357,876.03 ha at an increase of 1.96%. Though there was reduction of 5.8% (at 0.96% annual average forest loss) in primary forest as at 2018. The significant increase in forest cover was as a result of plantation forest which was about 5.4% at 0.90% annually since 2012 (Forestry Commission, 2019).

2.3 Plantation forest in Ghana

The government of Ghana in the 1990's implemented the new Forest and Wildlife policy to bring to bear the importance of active partnership between agencies and local communities in forest sustainability Osei-Mainoo (2012). In 2001, the

government launched the National Forest Plantation Development Programme (NFPDP) which included Modified Taungya System (MTS) and Private timber tree plantations with the former established in degraded forest reserves and the latter on individual lands (Asare-Kissiedu, 2014). MTS is the modification of the Traditional Taungya System (TTS) where there is partnership between the state and the local people in tree planting. The local people were given incentives to increase their participation in tree planting and its sustainability (Tufuor, 2012). Globally, plantation forest was about 187 million ha in the 21st century but has been projected to exceed 200 million ha by 2050 (Evans, 1992). With such focus, there has been a 25 year plan by the Ghana Forest Plantation Strategy (GFPS) to achieve a sustainable supply of trees (Forestry Commission, 2016). The strategy plans accounts for about 650,000 ha new plantation forest by 2040 which will be reviewed every five years for assessment.

The plantation forest in Ghana began through the "taungya system". In Ghana, plantation forest is done both by the state through the forest commission and by local people as private investors or farmers. For the purpose of this study, plantation forest was limited to forest established by local people on their own lands. The NFPDP programmes were revived in 2009 to improve on the local people's participation (Tufuor, 2012). Plantation forests are mostly practiced in the forest zone regions in Ghana since farming is the predominant activity in those communities. However, in the coastal areas like Winneba, there is low participation of local people in tree planting. Land owners who may willingly give out their lands for tree planting after few years (often less than 3 years) give up and clear the land for other use. Tree planting is rather intensified by institutions such as schools, associations in such areas. Plantation forest has sprung up an association called Private Afforestation Developers Association (PADO). PADO was formed in 2010 as economic sector-based organization to enhance

individuals in practicing afforestation in Ghana. It seeks to spearhead tree planting to reduce deforestation with a positive effect on climate change and to meet wood product demands. The association with its motto, "Tree is life" comprises small scale farmers, private investors and companies. Members of this association are located in Ashanti, Brong East, Ahafo, Oti, Western North and Western region.

On records their membership is 97 with most of their plantations located in the state's forest reserves whereas the small – scale farmers have theirs at the off-reserves.

2.4. Factors that intrigue the establishment of Plantation forest by local farmers

Forest are made up of several individual strands with diverse stages in terms of development and characteristics (Mya, 2010). FAO in 2012 defined forest as land with at least 0.5 hectares (ha) of trees which is 5 meters high and has a canopy cover greater than 10%. The practice of tree planting evolved from agro-forestry in the Middle ages where farmers combine tree planting and agricultural crops on the same piece of land (Nair, 1993). Plantation forest is synonymous to afforestation and reforestation. It is also termed as secondary forest. According to Evans (1992), plantation forest is a means of establishing forest by way of planting and or with seeds. The main catalyst to afforestation was the high rate of deforestation, wild fires and bush fires (Arnold, 2001). The establishments of forest by local farmers with their lands are determined by their reasons, land tenure, tree planting systems and the various tree species associated with plantation forest.

2.4.1 Reasons for establishing Plantation forest

The motives of farmers establishing forest on their lands are related to the product from trees and NTFPs (Mya, 2010). These benefits for this study are classified into economic, ecological and social. Pertaining to the economic benefits, tree planting

was powered by the monetary advantages derived from the sales of wood and wood products (Mukesh, 2003). About 90% of the world's plantation forest are well known to supply industries with wood product as raw materials (Kanowski, 1997). Roberts and Gautam (2003) attested to the fact that the economic benefits from tree planting exceed that of the other benefits such as carbon sequestration, regulating climatic condition and protecting water bodies. Tufour (2012) stated that, countries that are effectively involved in tree planting boost their Gross Domestic Product from Timber.

Moreover, the ecological benefits focus on the preservation of biodiversity and carbon sequestration. Although, it was initially rare for farmers to indulge in tree planting for environmental purposes (Arnold, 2001) yet recently, farmers plant trees to prevent desertification. Tree planting in China has brought about the re-establishment of small mammal in the forest (Wang, Qureshi, Qureshi, Qiu, Friedman, Breust, & Wang, 2015). Therefore, tree planting has been an acceptable means to prevent the loss of biodiversity. Incentives have been given to private individuals to establish forest for nature restoration (Strange, Jacobsen, & Bo, 2019). Political governments with stronger law enforcement also affect tree planting in an area (Tekalign, Flasse, Frankl, Rompaey, Poesen, Nyssen & Muys, 2018). A survey in China revealed that majority of local farmers are willing to establish forest but has not begun because there is inadequate policies and incentives backing tree planting (Liu, Zhang, Yu, & Zhou, 2018). Other local farmers indulge in tree planting to reduce erosion, regulate water and also to protect groundwater in their farms.

In addition, social benefits of tree planting were an essential part of farming activity where its ultimate purpose was to sustain food production (Nair, 1993). Trees have been a source of fuel wood for domestic use. Farmers also uses timber in roof their

houses and for furniture's. Local farmers venture into tree planting as a result of social ties. Majority of farmers in tree planting are members of afforestation organization such as PADO. This association provides assistance such as technical and financial to its members. Established forests have been a means of securing one's land for future use (Pomevor , 2014). This has prevented conflicts over bare lands among families.

2.4.2 Land tenure

FAO (2002) defined land tenure as the rights or rules governing the usage and the ownership of land among a group of people. These rules vary among clans, families, societies and nations (Heist, 2001). Rights and Resource Initiative (RRI) (2014 as cited in Paudyal, Baral, Lowell & Keenan, 2017) declared that 15.5% of the world's forests are managed and controlled by local people and communities. It was projected by RRI (2015) that 65% of the world's land area should be governed by the native people and their communities under the customary systems yet this has not been recognized as such by most governments. However, only 5% of community lands are recognized as fully owned and controlled. Strong tenure right leads to active participation and results in effective forest management. This fueled China's current status in afforestation of having 60% of the total forest lands under Plantation forest (Gilmour, 2016).

In West Africa, land ownership is mostly based on lineage where members must belong to the same ancestors or by monarchy in relation to the authority ruling the place (Bruce, 1998). Lands are further grouped into the patrilineal and matrilineal system. Bruce (1998) commented that, primarily, the right to land was given to men; however, women also had the privilege to possess land only through their husband, father or a male relative. Land tenure can be categorized as private, public, open access and communal (FAO, 2002). A study conducted by Yeboah and Shaw (2013) identified

three main forms of land ownership in Ghana which are public, customary and vested lands. According to Kasanga and Kotey (2001), 80% of the lands in Ghana are customary lands. Heist (2001) noted that, traditionally, in the southern part of Ghana, greater portion of the land belongs to the stool whereas in the northern part, land belongs to the skin. Insecurity in the ownership of land is a constrain to tree planting in several areas (Mwihomeke, Hamisy, Zilihona & Mwaseba, 2002). It can therefore be said that tree tenure is entangled to land tenure.

2.4.3 Tree planting system

Tree planting system is adapted from the planting systems used in food crop farming. These are basically mono-cropping/mono-culture, mixed cropping and land rotation planting system. Unlike food crop farming, tree planting are mostly established using mono-cropping system (Kanowski, 1997). According to him, the mono-cropping system yields greater output As projected by (Kanowski, 1997), plantation forests is mostly done using the monoculture system in other to produce wood products frequently for timber industries. Such trees also are able to grow tall since they do not compete with other crops for nutrients from the soil. However, to another school of thought, tree planting associated with mixed cropping have higher yields than that with mono-culture system (Rai & Schmerbeck, 2012). Also, mixed cropping is characterized with food crops and trees on the same land. According to Rai and Schmerbeck (2012) mixed cropping system also generate other returns aside wood product such as food crops and NTFPs. Land rotation which is also termed as shifting cultivation in farming is a planting system which is characterized with slash and burn during field preparation. Lands for farming are also allowed to fallow. This planting system is normally done alongside the mixed cropping system where there is the combination of long and short-cycle crops with trees (Appiah, Damnyag, Dwomoh & Pappinen, 2009). Land rotation

system is not often practiced due to the high demands of lands for settlement (Osei-Mainoo, 2012).

2.4.4 Tree species associated with Plantation forest

In relation to tree species features, trees in the savanna and dry woodland in West Africa are mostly of low height with discontinuous canopy (Onyekwelu & Yirdaw, 2006). Tree species are determined by rainfall patterns. Areas with low rainfall have less tree species as compared to those with high or medium rainfall like the moist and wet evergreen Forest belt. Deciduous forest and transitional zones also have numerous tree species. Forestry and timber plantation are established in the moist and semi-moist forests of a state (Onyekwelu & Yirdaw, 2006).Tree species diversity of an area is also influenced by fire outbreak. Areas that experienced rampant bushfires demand more of the fire- resistant tree species like Acacias, Boabab, African teak (*Pericopsis elata)*,Coast live oak and less of the fire- sensitive species like *Vitellaria paradoxa* (Onyekwelu & Yirdaw, 2006). Among most plantation forest in the world, the common species planted are *Pinus Araucaria, Gmelina, Larix, Pseudotsuga* or *Tectona, Acacia, Paraserianthes, Populus, Eucalyptus and Picea* (Kanowski, 1997).

In Ghana, Teak (*Tectona grandis*) has been the most common tree species among several plantation forest (Tufuor, 2012). This is because of its characteristics such as being weather and termite-pests resistant (Form International, 2013). In 2015, a report from the Forest commission indicated that, Teak forms about 70% of the plantation forest in Ghana (Duah-Gyamfi, Kyereh, Agyeman, Adam, Afriyie & Swaine, 2015). However, local farmers have now shifted to fast growing tree species like eucalyptus to meet its high demand (Nair & Tieguhong, 2004). In the northern part of Ghana, the common tree species grown in plantation forests are Cassia and Eucalyptus.

Trees species are mostly classified into indigenous and exotic species. Examples of the indigenous tree species are *khaya ivorensis* (mahogany), *Entandrophragma angolense* (sapele), *Ceiba pentandra* (ceiba), *Heritiera utilis* (niangon), *Triplochiton scleroxylo*(wawa, *Nesogordonia papaverifera (*danta), *Mansonia altissima* (mansonia), *Anogeissus leiocarpus* (African birch/Bambara ngálăma/siiga), *Afzelia africana* (African mahogany), *Pterocarpus erinaceus, Khaya senegalensi*and *Terminalia superba* (ofram). Examples of the exotic ones in Ghana are *Tectona grandis* (teak), *Cedrela odorata* (cedrela), *Azadirachta indica, Senna siamea*and *Eucalyptus torelliana , tereticornis* and *camaldulensis* (Duah-Gyamfi et al., 2015).

2.5. Forest cover change analysis

Forest cover worldwide keeps being influenced by other land uses as a result of rapid urban development (Mya, 2010). A study by Mujuri (2007) indicated that the deforestation rate globally as at 2005 to 2007 was almost 13 million hectares yearly. Forty percent of the deforestation occurred in primary/frontier forest (Mujuri, 2007). Forest cover in Africa during the mid-20th century recorded low rate of deforestation because forests were protected through rituals and sacred activities (FAO, 2012). Nonetheless, Africa in the late 20th century records the highest deforestation rate among other continent (Mya, 2010). FAO (2006) commented that the annual rate of deforestation in West Africa in 21st century was 0.64% per year especially among Ghana, Nigeria and Togo.

Again, forest cover change of a country is mainly affected by political regimes, social conflict, illegal encroachments, population growth and land policy (Tekalign, et al., 2018). The basic tools used in analyzing forest cover change in less time are the Geographic Information System (GIS) and Remote Sensing (Asare-Kissiedu, 2014).

With this, data of inaccessible areas are obtained from remote sensed data for the analysis. For this study the forest cover change analysis will be limited to the Land-Use/Land Cover (LULC) classification and land-use/cover change, accuracy assessment and the effects of anthropogenic/natural activities to forest cover.

2.5.1 Land-Use/Land Cover (LULC) Classification

LULC change analyses the physical changes as a result of human modification to the earth surface (Mya, 2010). These changes comprise the difference among the near-past, present and near-future state of an area. LULC focuses on the current usage of the land. Nonetheless, a single class of land cover may have several land uses (Nigussie, 2016). In other words, a conversion of one land cover class into another class is as a result of the change in land use. According to the FAO, LULC classification can be done using the dichotomous phase or modular-hierarchical phase (Di Gregorio & Jansen, 2000). The initial phase comprises 8 major land cover types and these are cultivated and manage terrestrial areas, natural and semi-natural terrestrial vegetation, cultivated aquatic or regularly flooded areas, natural and semi-natural aquatic areas, artificial surfaces and associated areas, bare areas, artificial and natural water bodies (Di Gregorio & Jansen, 2000). The latter phase divides the 8 major land cover classes into further detailed classifiers in a chain of command.

Also, Anderson LULC classification system classified land into Forest land, rangeland, water bodies, agricultural land and residential land (Torahi & Rai, 2011). Based on these system, Asare-Kissiedu (2014) in his study classified Worobong South (Ghana) into closed riverine vegetation, open riverine vegetation, dense shrub/herbaceous, grass/herbaceous and built up/bare areas. In the city of Port Harcourt (Nigeria), the land-use/cover classification for the area was water bodies, residential, swamp, farmland and vegetation (Mmom & Fred-Nwagwu, 2013). Again, a study in

Tirupati (India) classified the land-use/cover classification as mainly forest, agricultural land, wastelands, water bodies and built-up land (Arveti, Etikala, & Dash, 2016).

Furthermore, land use is an investment and so landowners evaluate and put their lands into use, the one with massive returns. Some of the factors that bring about land conversion are economic, political, cultural, demographic, natural disasters and agro-technological factors. These factors have led to landowners clearing portions of their forest for cash crop planting such as cocoa, rubber and cashew plant (Tekalign, et al., 2018). This also confirms Nigussie (2016) assertion that greater portions of woodland and forest resources have been converted into farm lands. This is not different from the study area region where Osei-Mainoo (2012) also declared that human activities such as farming, illegal logging and bush fires have significantly affected the forest cover.

In the mid-20th century, 5.2 million ha of Ghana's forest cover were converted to bare lands through the slash and burn farming system (Osumanu & Ayamga, 2017). Also, in the 2000s, greater portion of Ghana's forest cover were converted into grassland and bare areas (Asare-Kissiedu, 2014).

2.5.2 Accuracy Assessment

Accuracy assessment is vital component in ensuring a successful image classification (Rwanga & Ndambuki, 2017). This assessment deals with comparing the classified images with ground truth data of an area under review. In assessing the accuracy of the geo-data, producer's accuracy, user's accuracy, Kappa coefficient and overall accuracy are required (Rwanga & Ndambuki, 2017). An overall accuracy shows how the classified pixels selected correspond to what is on grounds. Kappa coefficient also determines whether the image is significant in examining the extent of land cover in the study area. The level of prediction in classifying the land cover maps is

synonymous to the producer accuracy whereas the user accuracy determines the error of commission (Rwanga & Ndambuki, 2017). Therefore, the difference between the user and producer accuracy establish how that land cover class was assumed to be other land cover types (Peacock, 2014). That is, the wider the difference in the accuracy, the greater error in the classification and vice versa. The overall accuracy is considered reliable when it is approaching one (Mya, 2010).

2.5.3 Effects of anthropogenic and natural activities on Plantation Forest

The activities of man such as tree planting, bush burning, building construction, illegal logging and the likes affect the extent to forest cover either positively or negatively. Meanwhile, the natural activities look at regeneration, wild fires, invasive species, landslide, and earthquakes. For this study, both the human induced and natural activities is limited to tree planting, bush burning, illegal logging and invasive species.

2.5.3.1 Tree planting

Tree planting are principal means of increasing forested areas amidst deforestation and forest degradation. The "human intervention in tree planting" concept depicts the growth of forested areas with human being as the pivot for this activity (Singh, 1992). Teak trees are coppices which produce multiple stems as it grows but when not pruned, root competition prolong the maturity of trees(Form International, 2013). Trees harvested with time are replaced naturally by coppices. Tree weight and length may be affected by natural phenomena which may affects its carbon intake Studies showed that temperature, precipitation and soil thickness drastically influenced forest growing stock (Yang, Watanabe, Li, Zhang, Zhang & Zhai , 2006). For instance, low temperature increases the stem volume of tree and vice versa due to the decrease in evapotranspiration.

2.5.3.2 Bushfires

Bush fires are the most frequently caused by farmers in the process of slash and burn and at times by game hunters or charcoal burning operators. Pertaining to this present study, it is only the former that occurred frequently in the district. A research by Asare-Kissiedu (2014) examined that bush fires have been one of the problems affecting forested areas. His findings showed that, two thirds of farmers in MTS in Worobong Forest Reserve had great fear of fire (wildfire and bush fire) and its effect on forest cover because of the frequent experience. Though in Ghana, the common species planted is fire resistant (Teak), bush fires are harmful to trees and destroy the teak regeneration (Form International, 2013). Fire also retards the growth of trees and affects the weight of tree species. An effective means in preventing the spread of fire is through the making of fire belts and constant pruning (Onyekwelu & Yirdaw, 2006). These practices promote growth in the forest cover.

2.5.3.3 Illegal logging

The degree of ownership is accompanied by the rate of monitoring and protecting trees. Ravn and Simonsen (2007) discovered that illegal harvesting of trees on private lands almost do not happen since such areas are under strict supervision with severe punishment when caught. Osei-Tutu (2018) stated that forest in total management by community folks yields a positive result such as decrease in illegal activities. This has brought about an improvement in forest management and sustainability in community forestry. However, this contradicts the findings of Ampofo et al. (2015) that MTS (a component of community forestry) records high rate of illegal logging as compared to the established individual forests.

2.5.3.4 Invasive species

Invasive species are plants such as York (*Broussonetia papyrifera*) and Akyeampong (*Chromolaena odorata*) that compete with the trees for food nutrient and delay the growth of trees or cause younger ones to die. The existence of herbaceous and other invasive plants decrease the rate of regeneration of other species (Duah-Gyamfi , Kyereh, Agyeman, Adam, Afriyie & Swaine, 2015). To others the exotic tree species such as Teak are seen as invasive species because they threaten the survival of other tree species (Onyekwelu & Yirdaw, 2006). Also, to Mwihomeke et al. (2002) Cedrela odorata are considered as invasive species because it mostly interrupts the condition of other tree species of the forest.

2.6 Benefits of Plantation Forests

The primary purpose of forest is mostly determined by the owner of the land. The benefits for this study are grouped into two; Protective and Socio-economic functions. The assessment of forest resources initially centered on economic functions (Forest Resource Assessment (FRA), 2010a).

2.6.1 Protective functions of Plantation Forest

Protective functions focus on how trees cause a balance in the ecosystem resulting in the sustainability of biodiversity. In terms of water and soil conservation, trees reduce runoff velocity, soil erosion and enhance infiltration. Tree roots help in binding the soil to prevent erosion. They help promote favorable conditions for agricultural farming through the protection of soil and water. Trees serve as shade, fencing and windbreaks. All these affirms a report by Forest Resource Assessment (2010) that about 330 million ha of the world's forests are chosen to conserve water and soil, balance sand dune and minimize desertification and avalanche. The presence of trees reduces the amount of carbon dioxide (CO_2) during photosynthesis from the

atmosphere. According to Roorda (2012), carbon dioxide plays a vital role in the greenhouse effect which brings about global warming. He emphasized that, CO_2 contributes 54% to the greenhouse effect. Therefore, less of CO_2 as a result of tree planting reduces its effects such as pollution and changes in weather phenomena. Geta, Nigatu and Animut (2014) claimed that, trees serve as sinks for CO_2 and methane, another greenhouse gas. Tree planting has therefore been a means of mitigating climate change in the world.

2.6.2 Socio-economic functions of Plantation forest

Economic functions emphasize on the output of trees such as timber, fuelwood, fiber, food, fodder and NTFPs. In Forest Resource Assessment (2005), trees have been known as a provider of goods and raw materials to local people and industries. Globally, forest areas with 2.8% in 2005, 2.4% in 2000 and 1.9% in 1990 were allocated for economic function (Forest Resource Assessment, 2005). Trees as raw materials are used for furniture, stationary (such as paper, pencils), building industries, ship building, fishing boats, musical instruments and railway ties. Also, in Africa, trees served as the main source of energy where 80% of all wood in the region are used for fuel (FAO, 2012). Again, forest industries worldwide provide employment to about 47 million people in the world(Arnold, 2001). For instance, Forest Resource Assessment (2010b) reported that forestry provides the highest level of employment in Asia which comprises about 8.4 million people. Forest products and services thereby help to alleviate poverty. Forests generate recreation and tourism which enhances a healthy society and improves culture. According to FRA (2010b), 4% of the world's forest are selected to provide social and cultural services. NTFPs such as herbs and traditional medicine are also derived from the forest. About a billion of people depend on medicine made from forest plants (Mayers & Vermeulen, 2002). Natural and green spaces help

in releasing stress, overcoming depression, reducing additional fatigue and promote physical rehabilitation. These make the forest environment therapeutic and a source of raw material to pharmaceutical companies. Forest also helps build up people's confidence in management and decision making. Mayers and Vermeulen (2002) in their findings concluded that local people's involvement in forestry was an initiating means of implementing local governance.

2.7 Challenges of Plantation Forest

Plantation forest as a form of forest decentralization helps in managing and sustaining forest cover; however, just like any other form of forestry, it is characterized with these challenges. Firstly, access to land to be used for plantation forest becomes a challenge. FAO (2000) concluded that as a result of the increasing population, land is becoming more intense with human settlement. There is a competition between land for crop farming to meet the population demands and lands for urban development. According to Subasinghe (2014), lands suitable for plantation forests are difficult to come by of late. Available lands may be infertile which has been abandoned as a result of other cultivation especially rubber.

Moreover, lands leased to farmers for tree planting may at times be taken from the local farmer even when the contract is not due. The owners obtain clear trees and use their lands for other activity with high economic value. Lands with issues of ownership are likely to encounter similar problems. Furthermore, another challenge farmers' face is the adequate information on tree species. Studies on site characteristics, growth enhancement, pests and diseases measures assist farmers in their choice of tree species in plantation forestry (Subasinghe, 2014). Most farmers perceive that specific species that thrived in certain place should do well at other places. This may not be so due to the characteristics of the soil and the climatic condition of places. In addition,

another major constraint local farmers' face is inadequate finances. Plantation forest normally requires a high capital at the initial stage. Trees take quite a number of years to mature hence farmers with no alternate livelihood activities becomes poor during this period. With this some may clear the land to be used for other farming activity such as crop or livestock rearing. Lastly, unexpected disasters are bound to happen during the tree plantation. Examples of such disasters are fires, pests and diseases. Some of the tree species may be vulnerable to these disasters thereby prolonging its maturity and tree yield. For instance, Teak and Eucalyptus are vulnerable to fire whereas Mahogany is vulnerable to insect attack by Hypsophylla (Subasinghe, 2014).

2.8 Summary

Most of the world's primary forests have massively been transformed due to deforestation. At the end of the 20th century, 56% of the global loss of forest cover was from Africa. However, that of plantation forest was 135 million ha representing 4.0%. In 2018, Ghana recorded a net gain of 1.96% in forest cover mainly as a result of the establishment of plantation forests. The main motive for the establishment of forest by farmers has been for economic, environmental and social purposes. Teak (*Tectona grandis*) is the most common tree species among several plantation forest followed by Cedrela, Eucalyptus and Cassia in Ghana. For the forest cover change analysis, the area under review is classified into the various LULC classes. The classified images also undergo accuracy assessment. Plantation forest basically provides protective and economic functions to people and its environment. The challenges local farmers face in tree planting are unexpected circumstances such as fires, land tenure right, inadequate capital and information on tree species.

Recently, the focus of deforestation and sustainable forest management across the globe has been widely investigated where several measures in mitigating it has been

revealed. Prior studies have shown that much attention has been on reclaiming nation's degraded forest reserves through forest decentralization in Ghana. Also, much has been dealt in the area of community forestry to improve tree planting and poverty reduction. All these are to help in increasing the world's forest cover to mitigate global climate change and to meet the demands of trees. However, there are also studies that suggested that the world's forest cover can increase through the establishment of plantation forest, mostly done by individuals on their own lands. In some studies, economic benefits have been the catalyst for plantation forest whereas in others, it has been to reduce deforestation and preserve biodiversity. In the meantime, the area of plantation forest has not been thoroughly investigated globally in bringing out the role of plantation forest to global forest cover for the past 15 years. Studies in plantation forest in Ghana also focus mostly on the mitigation of climate change leaving out factors that promote plantation forest and the extent of such area. In these situations, I present the factors that intrigue the establishment of plantation forest and its total area achieved over a period of 30 years in the study area. With this information, measures can be put in place to improve plantation forest in other part of the country. In addition, the theories underpinning this study are the Socio-Ecological Systems (SES) where "Human intervention in Tree Planting" concept is adapted together with the Support Service Model.

2.9 Theoretical Framework: Socio-Ecological Systems (SES)

Social and Ecological theories were propounded in the 1970's where the former was by Ludwig von Bertalanffy and the latter by Urie Bronfenbrenner (Friedman & Allen, 2006; Bronfenbrenner, 1999). The Social theory focuses on the interdependence among systems whereas the Ecological theory emphasizes on human development in relation to its environment such as the forest.

The relation between the Social and Ecological theories can be termed as "people – with – nature" in an ecosystem (Pérez-Soba & Dwyer, 2016). For this study, the concept is adapted as "human beings – with – forest" where human beings and forest are the systems. According to Redman, Grove and Kuby (2004), there should always be an interaction between the systems in a sustainable manner. Halliday and Glaser (2011) add that, SES is the assemblage of human, non-human (plants and animals) and geophysical elements (water, soil) where human's activities affect the processes of the other elements. Hence, human beings' activity affects other elements in an ecosystem. For the effectiveness of the relationship between forests cover and human's development, measures such as forest management and sustainability have to be ensured.

Plantation forest goes beyond the planting of trees to protecting and sustaining the trees planted. To effectively undertake this, there has to be a high degree of ownership, decision making, forest protection and management (Binod, 2016). The disparities in the degree of ownership led to the various models of community forestry (Singh, 1992). Among the models is the "Support Service Model" which is tantamount to plantation forest. This model greatly ensures the sustainability of forest resources.

2.10 Conceptual Framework: Human intervention in Tree Planting

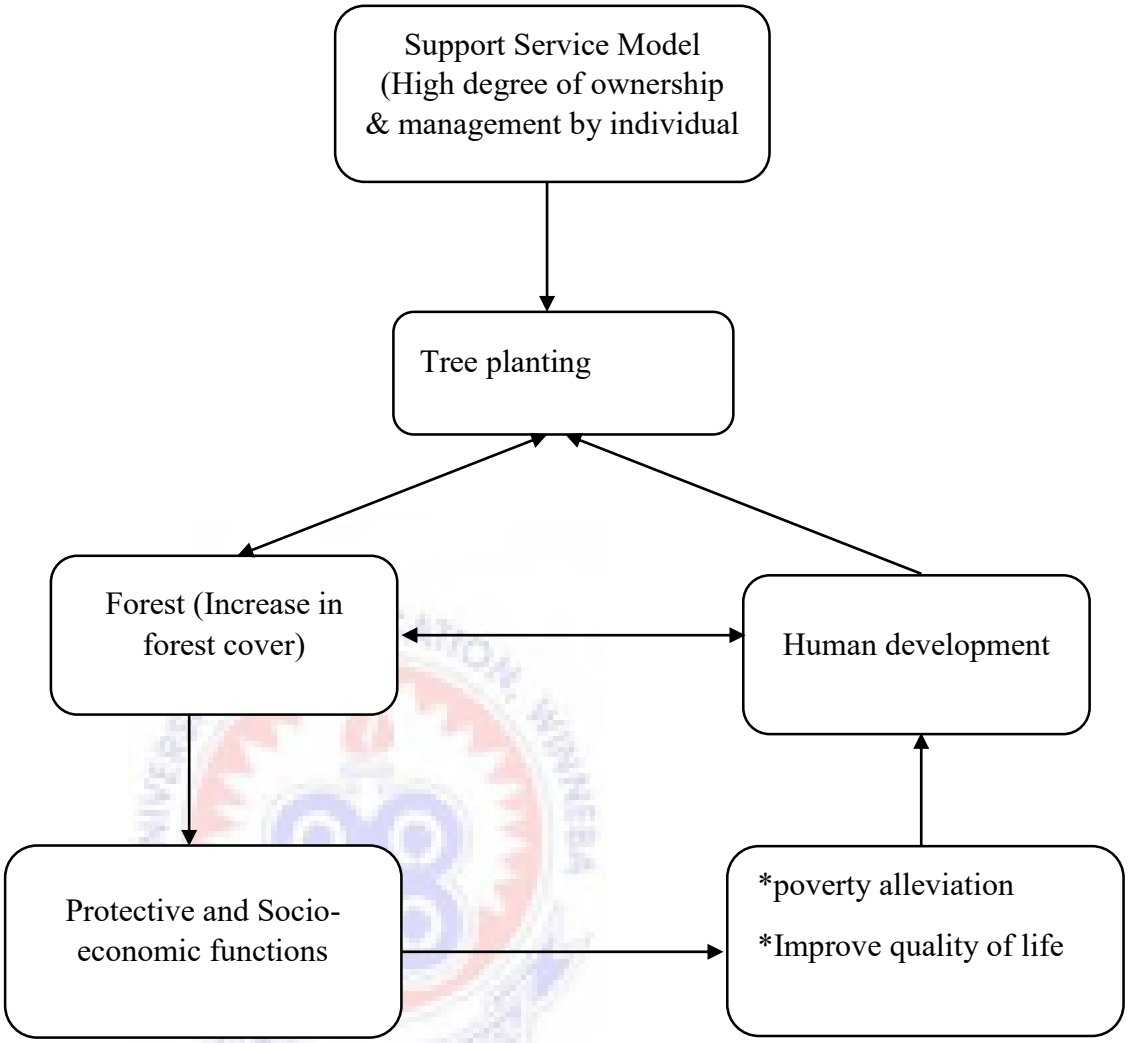

Figure 1: Human intervention in Tree planting

Source: Author's construct based on ideas from SES and Models of CF

For this study, the Ecological theory brings to light the relationship between the Social systems (human beings and forest) and its effect on human socio-economic wellbeing. With the Support Service Model adopted, there is high degree of ownership and forest management among local farmers hence it positively promotes the planting of trees in the society. Tree planting increases the forest cover and provides protective and socio-economical functions. The protective functions include shielding water bodies, constant supply of oxygen and protecting soils.

Plantation forest also assist as buffer zones to serve as habitat to forest plants and animals especially those that have been displaced by deforested frontier forests (Onyekwelu & Yirdaw, 2006). For socio-economic function, income is obtained from the sales of Timber and non-timber forest products (NTFPs). This also alleviates poverty among the forest fringes communities. Therefore, it is hypothetical that a change in forest cover affects human socio-economic wellbeing. This influences man either to increase or decrease the forest cover through tree planting and harvesting.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the profile of the study area, Offinso North District in relation to its location, size, extent, physical characteristics, tree species and the socio – economic activities. It also explains intensely the methods that were used for the study, thus, the research approach, design, sampling technique, size, data collection and analytical technique used to analyze the data. It further defines the procedure to determine the forest cover change in the study area.

3.2 Profile of the study area

The study area is Offinso North District in the Ashanti Region. The District lies within longitude 1˚45W and 1˚65W. It covers an area of about 946 km^2 which is about 2.6% of Ashanti Region's total surface area (Ghana Statistical Service, 2019). The District lies within the semi-equatorial region with a bi-modal rainfall regime. The population of the District, according to the 2010 Population and Housing Census stood at 56,881 with the percentage of males as 49.8 and females as 50.2(Ghana Statistical Service, 2014). The District population was estimated to 65, 965 at a growth rate of 2.5% in 2016 but has increased to 69, 760 as at 2019(Ghana Statistical Service, 2019). The natural vegetation of most part of the district is moist semi-deciduous forest with thick vegetation cover and under growth. Farming is the major occupation in the study area with about 75.4% of the population (Ghana Statistical Service, 2014).

3.2.1 Study Area Map

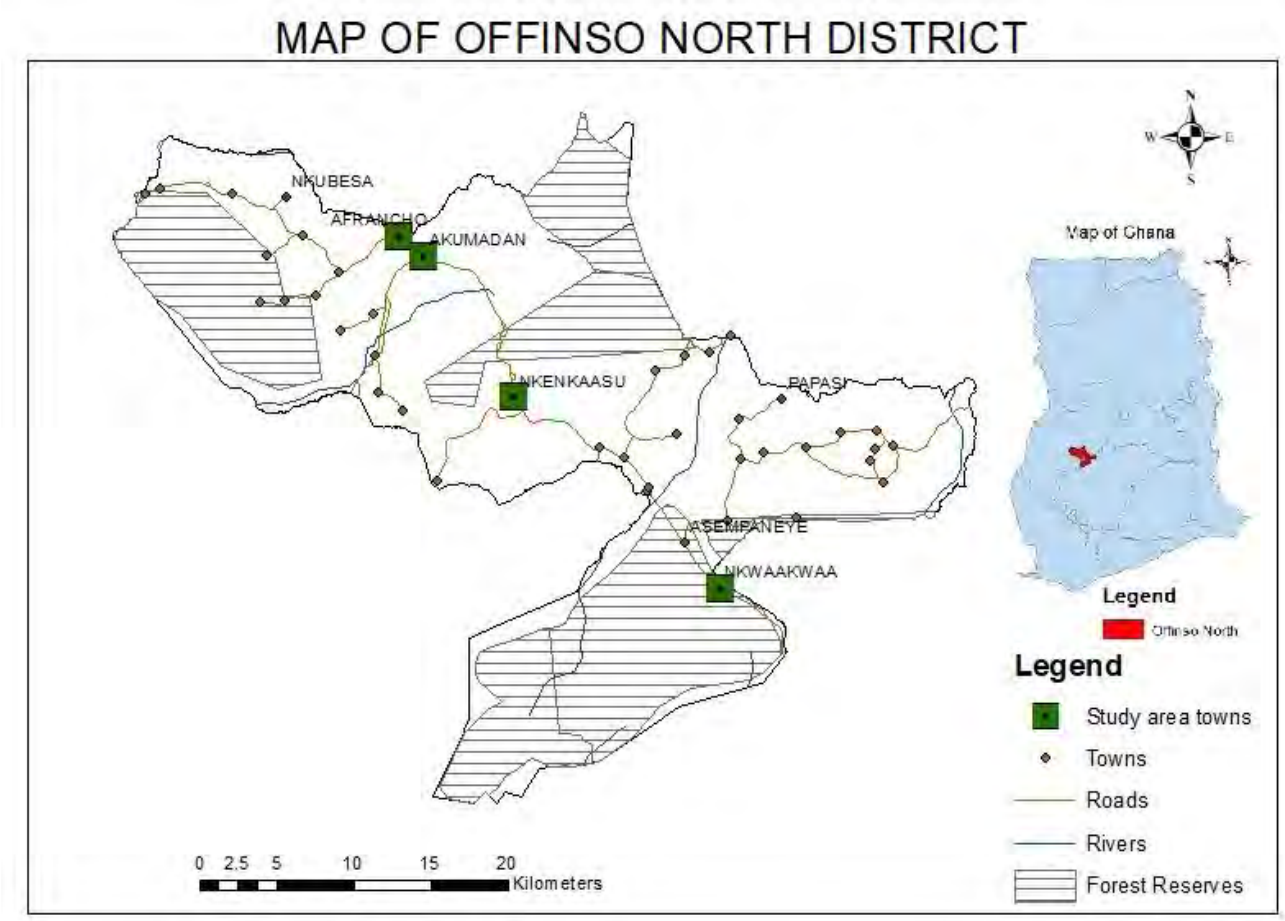

Figure 2: Map of Offinso North District

Source: Authors construct, 2020

3.3 Research design

The research used the mixed method approach. This approach is the combination of qualitative and quantitative data employed for analysis (Yin, 2009). The focus for this study was to examine the factors that lead to the establishment of plantation forest and the forest cover change analysis within a period of 30 years. With this, it was prudent I obtain both qualitative and quantitative data in analysing the objectives for the study. In view of this, the study falls under the pragmatic philosophy which focuses on the integration of both qualitative and quantitative data (Creswell,

2014). This was used to provide in-depth information on the establishment of plantation forest in the study area and the changes in the forest cover over time. Again, data (qualitative and quantitative) obtained for the study minimize the shortcomings of the qualitative and quantitative methods. According to Creswell (2014), the pragmatic philosophy also gives one the freedom to choose a technique or design that best meet their needs hence I used the descriptive cross - sectional survey design for this study. This design involves obtaining information about the characteristics, thoughts and activities of a group of people at a point in time (Showkat and Parveen, 2017).

3. 4 Sample and sampling techniques

In the absence of a definite population for a study, it becomes difficult in determining the sample size. This reflected in the study area as there was no defined number for farmers who had established plantation forest. Creswell (2014) elaborated on the fact that in mixed method approach, quantitative data tends to be higher than that of the qualitative data. Therefore, I employed a formulae by Cochran (1963, 1975) as cited in (Ajay and Micah, 2014) in estimating the sample size. At a confidence level of 95% (Z = 1.96) with 5% margin of error (d = 0.05) and an estimated proportion as 10% (p = 0.1). The sample size was obtained using the formula;

$$n = \frac{Z^2(p(1-p)}{d^2} = \frac{1.96^2(0.1(1-0.1)}{0.05^2} = 138.3$$

With this, the sample size for the study was approximated to 135 respondents. This is because out of 140 questionnaires obtained, 5 of them did not fall in the inclusion criteria for the study. Also, the sample size for the qualitative aspect of this work was three out of the five national PADO executives. The qualitative aspect focused on the factors that motivated people to establish forest and its challenges. This data was obtained using interview guides and observations. However, that of the quantitative

data focused on the forest cover analysis and it was obtained using semi-structured questionnaire, GIS and Remote Sensing.

In obtaining the qualitative data, purposive technique was used in choosing communities where local people practice plantation forest. Communities selected were Afrancho, Akumadan, Nkenkaasu and Nkwaakwaa. Also, I used convenient sampling in selecting three out of five PADO executives because they reside in the Ashanti Region where they were accessibly available to the researcher. Questions concerning what have been done about the challenges people faced in plantation forest and the motives for its establishment could be well addressed by the PADO executives.

3.5 Source of Data

To achieve the set objectives, both primary and secondary information on plantation forests were obtained. The main sources of primary data were from semi-structured questionnaire administered to the respondents of the study. In addition, secondary data was obtained from journals, articles and reports, information on the history of forestry, plantation forest, forest cover change analysis and the challenges of plantation forest. This enabled me in gathering the primary data to broaden the scope of the establishment of plantation forest and its role in forest cover. I also obtained geo-data from Landsat images and Google earth explorer to aid me with the forest cover change analysis of the study area

3.6. Instruments for data collection

The main instruments employed for this study were the questionnaire and interview guide. The questionnaires were administered to the local farmers that had established plantation forest on their lands in the selected communities. Also, the interview guide was given to the national executives of PADO to be completed.

3.7. Piloting of the questionnaire

A vital means of assessing the usability of a research instrument is by using the instrument in another area with the similar features as the study area. I first visited the study area in July, 2019 during the pilot study and became conversant with the study area. A reconnaissance survey was carried out in January, 2020 in Ahyiayemu in the Bono East region. In all, 10 local farmers responded to the questionnaire. Their data was then input in SPSS to ensure the reliability of the questions and how they can address in solving the research questions set for the study. After conducting it, none of the questions was removed. This made it possible to use the questionnaire in the study area.

3.8. Data collection procedure

The data collection took off in March and lasted for three weeks. Data collection was done with the help of 5 research assistants. In using systematic sampling, the third household in every village was considered. The interval was three because some of them fell in the systematic order yet did not meet the inclusion criteria. Respondents' consent was sought by first explaining the aims and objectives of the study to them. They were then asked whether they would want to be part of the study or not. The questionnaires were further explained to those who agreed to be part whereas those who did not agree were excluded from the study. Respondents were contacted in their various homes and shops. Farmers were followed to their farms to gather further information on the acres of land, tree species planted and its location (whether off reserves or on-reserves). Only those at the off-reserves were considered for the study. On the field, the number of acres were measured and documented to confirm what the farmers said. The research assistant also helped in putting down the respondent's responses. Pictures of their plantation forest were taken on the field.

3.9 Data analysis procedure

The questionnaires obtained were numbered to help keep track and prevent double entering of the same questionnaire. Recorded interviews I had for the study were transcribed. Data obtained from questionnaire and interviews were analysed quantitatively and qualitatively respectively. In the quantitative analysis, descriptive and inferential statistics were employed using the software called the Statistical Package for Social Sciences (SPSS) version 25.0. With this, descriptive statistics were used to derive percentages, frequencies, bar graphs and pie charts to analyze the data. Inferential statistics such as Pearson correlation was used to test the research hypothesis. Also, information from interviews were grouped into themes based on the research questions.

3.10 Description of the quantitative data for forest cover change analysis

In relation to the extent of forest cover in the study area, three time periods (1990, 2015, 2020) were used. This is the most common approach for land cover change analysis as was used in assessing the forest cover in Worobong South Forest Reserve in the Eastern Region of Ghana (Asare-Kissiedu, 2014). Kumar (2011) said that for a change detection in forest cover, at least a minimum of two time periods is required for the analysis.

3.10.1 Satellite Imagery

The study used satellite images from United State Geological Survey (USGS) and Google Earth to determine the changes in forest cover in the study area. The FAO classification was adopted in classifying the land cover of the Landsat TM satellite images for 1990, 2015 and 2020. Overlay analysis was conducted using ERDAS IMAGINE 2013 and Arc GIS. Remote sensing and GIS were used as tools to analyze

the changes in forest cover of the study. These images were obtained from Landsat 8 Operational Land Imager (OLI), Thermal Infrared Sensor (TIRS) and Landsat 1-5 MSS C1 Level -1, all from the United States Geological Survey (USGS). The images for the study were taken between December and January because images taken during dry season do not have clouds on it as seen in Table1. The analytical software used was ERDAS Imagine 2013 and ArcGIS version 10.5.

Table 1: Satellite images and their features

Satellite	Data (Month/Year)	Data season	Bands used
Landsat 5 Thematic Mapper (TM)	December, 1990	Dry Season	5, 4, 3
Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)	December, 2015	Dry Season	6, 5, 4
Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)	January, 2020	Dry Season	6, 5, 4

Source: Author's Construct, 2020

3.10.2 Image Stacking

Monochromatic bands of each downloaded image were stacked. Bands 5, 4, 3 and 6, 5, 4 of Landsat 5 TM data and Landsat 8 OLI/TIRS were used for the stacking respectively.

Here, these bands were combined into one image in ERDAS IMAGINE 2013 by clicking on 'Spectral' under 'Raster Menu', clicked the 'Layer stack' and added the selected bands.

3.10.3 Data Pre-Processing

This is the stage where the stacked images underwent radiometric, haze and noise correction before they were classified. The radiometric corrections minimized the effects of atmospheric factors by correcting line stripping and the period line dropouts. Haze and noise corrections also corrected disturbance factors. After these corrections, the images were classified.

3.10.4 Image Classification

Unsupervised classification of 150 classes per the satellite images (1990, 2015 and 2020) were run for the study area at a maximum iteration of 100. With the help of Google Earth Pro by means of ground truthing, the unsupervised classes obtained were grouped into five (5) major classes. The unsupervised classification has a high degree of objectivity which allows one to describe the features of a given area just as how it appears on the ground. This confirms Yang and Lo (2002) assertion that unsupervised classification spectral clusters are impartial and allows one to determine in reality how an area is in a pictorial form. The five (5) classes were based on the Food and Agriculture Organisation (FAO) classification using the tertiary level as seen in Table 2 for easy diversity. This was done using the supervised classification in ERDAS Imagine by the help of the signature classes which were obtained through the unsupervised classification.

Table 2: Land Cover Classification

Land cover and Land use Type	Description
Built up Areas	Areas that have an artificial cover as a result of human activities such as houses, factories, roads, quarries etc.
Bare Areas	Areas that do not have an artificial cover as a result of human activities.
Farm land	Areas of vegetative cover which is planted with the aim to harvest later. Examples; Cocoa plantation and maize/millet fields.
Forested	Areas covered with mature trees growing close together
Water Bodies (Artificial & Natural)	Areas that are covered by water either naturally such as lakes, rivers and streams or induced by man such as pond

Source: Author's Construct adapted from Di Gregorio & Jansen (2000).

The ISODATA (Iterative Self-Organizing Data Analysis) algorithms in ERDAS Imagine was used to identify spectral clusters. ISODATA method make use of minimum spectral distance to assign a pixel to a cluster. The land cover changes for 1990 – 2015, 2015 – 2020 and 1990 – 2020 were calculated by subtracting the area of former year from the latter year among the years under review. It was then divided by the total area and expressed as a percentage.

3.10.5 Data analysis procedure

After obtaining the supervised map for the years under reviewed, image accuracy assessment for the three images (1990, 2015 and 2020) was performed using aerial photographs, topographical maps and indigenous knowledge. I adopted the stratified random sampling design in selecting reference pixels for further assessment. I also used obtained confusion matrix, Kappa coefficient, producer and user accuracy to determine the overall accuracy for the maps. An overlay analysis of the classified images was done against each other using 1990 as the base year. This was done to determine the LULC change of the various land cover classes within the period under review. Using the ERDAS Imagine 2013 software, I clicked the Raster button on the menu bar and the Thematic Toolbar was selected. Then, Matrix Union function from which the two years compared was selected and inputted for the process to be ran. This produced an image showing the changes that have occurred between the two years scrutinized. Excel spreadsheet was used to calculate the rate of change among the three years. The final overlay output maps were produced using the ARCGIS.

3.11 Ethical Clearance

Ethical clearance was obtained from the Committee on Human Research and Publication and Ethics of KNUST. Approval was granted by the D.C.E of Offinso North District. Consent forms were also prepared for respondents. It was read and explained in the local dialect for participants who could not read and write before their approval was taken.

CHAPTER FOUR

PLANTATION FOREST AND FOREST COVER CHANGE ANALYSIS

4.1 Introduction

This chapter analyses and discusses data on respondents' demographics and factors that have influenced local farmers in establishing plantation forest in relation to the literature reviewed. Also, the forest cover change analysis of the study area within a period of 30 years (1990-2020) was presented and discussed. The effects of anthropogenic and natural activities to forest cover changed were also discussed.

4.2 Respondent demographic information

The study assessed the demographic information of the respondents in the study area. Results are presented in the Table 3.

Table 3: Respondents demographic characteristics

Respondents Age		**Marital Status n (%)**	
Mean	58.39 (±15.009)	Single	13 (9.6%)
Gender n (%)		Married	106 (78.5%)
Male	Female	Divorced	5 (3.7%)
103 (76.3%)	32 (23.7%)	Co-habiting	2 (1.5%)
Are you a member of PADO?		Widowed	9 (6.7%)
Yes	45 (33.3%)		
No	90 (66.7%)	**Level of Education**	
		No formal education	41 (30.4%)
How did you join PADO?		Primary	32 (23.7%)
Relative/ friends	33 (24.4%)	JHS	44 (32.6%)
Information centre	7 (5.2%)	SHS	13 (9.6%)
Announcement at gatherings	5 (3.7%)	Tertiary	5 (3.7%)

Source: Field Survey, 2020

From Table 3, the mean age of the respondents was 58.39 (±15.009) years. Most of the respondents in this present study were above 50 years. This is attributed to the fact that the youth prefer white collar jobs to farming. These findings affirms a study by Osei-Mainoo (2012) where majority of the farmers in MTS were above 50 years. Also, the younger people who are interested in farming prefer projects whose dividends is within the shortest possible time such as tomato, maize and cashew farming. They are therefore not attracted to plantation forest where most trees take more than 10 years to mature. Meanwhile, most of the respondents especially those above 80 years attested to the fact that they have employed the youth due to the vigorous nature of plantation forest whiles they supervise them. The younger respondents in this present study also

complained of not having lands to plant trees on. One respondent who was below 30 years for instance commented that;

My friends would have love to plant trees alongside teaching but they have not yet had lands for tree planting.

Majority (76.3%) of the respondents were males whereas the rest of the 23.7% were females. This is due largely to the rigorous nature of plantation forest. This type of farming requires constant pruning and the making of fire belt against bush fires. It therefore discourages females who want to venture into plantation forest. Regarding their marital status, a higher percentage, 78.5% of the respondents were married and 6.7% were widowed. The married group said they involve their household in the planting of trees therefore their plantation forests are cared for in their absence. Almost all the widowed were females who have inherited the plantation forest from their spouses. In terms of education, the farmers who had completed tertiary (3.7%) were retired teachers and workers from forest – oriented businesses. They responded that they are into plantation forest to be active whiles aged.

This present study further reveals that only 33.3% of the entire sample population were members of PADO. These people heard and joined the association from relatives, friends, information centers through announcement at social gatherings. PADO is well known in towns closer to Offinso Municipal (that is Nkwaakwaa and Nkenkaasu) than the outskirt of the district such as Akumadan and Afrancho. Therefore, majority of them (66.7%) who were at the outskirt of the District were not members of PADO.

4.3 Factors that intrigue the establishment of Plantation forest by local farmers in Offinso-North district.

4.3.1 Reasons for establishing Plantation forest

The study further assessed the various motives of respondents in using their lands to establish forest. These results are presented in percentages in Figure 3.

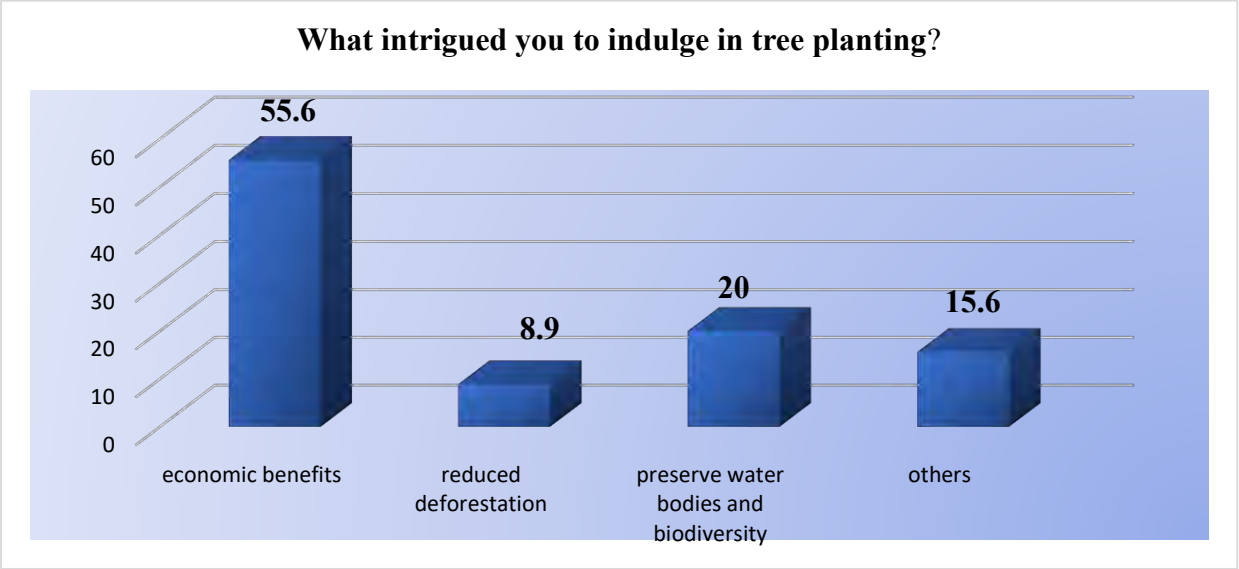

Figure 3: Reasons for tree planting

Source: Field Survey, 2020

The study revealed that more than half of the farmers (55.6%) indulge in tree planting because of its economic benefits from the sales of wood. The economic benefits related with tree planting were the income from the sales of timber and other tree product such as charcoal, roof and furniture. This agrees with Kanowski (1997) assertion that 90% of plantation forests worldwide have been established mainly to offer industrial wood for economic benefits. Mukesh (2003) also reported that the prime use of trees was for production of timber to satisfy human wants. One of the respondent's (I.B from Nkenkaasu) said that;

I am using my lands for tree planting because I am a timber contractor and at times, I find it difficult getting trees to buy from other people.

Also, 20% of the farmers said they plant trees to preserve water bodies and soil whereas 8.9% of them do so to reduce deforestation. According to some of these farmers, they rely on streams in their farms for domestic purposes. They therefore plant trees close to the water bodies on their farms in order to sustain the levels for use. This contradict Mujuri (2007) assertion that people will always harvest trees than to plant it as population increases. Some of the respondents had interest in tree plantation because of their passion and initial occupation related to forest – based business such as forestry commission, nursery supplier and tree trimmer. Regardless of the benefits, other farmers (15.6%) establish forest for social benefits such as an investment for their children. Other factors for people planting trees were the inability of their lands to support crop production and trees as wind breaks. Pomevor (2014) reported that local people's ownership to land tenure interests is becoming more insecure and others losing their right to leasehold. This has led to some farmers using plantation forest to secure their lands.

4.3.2 Land acquisition/ownership of Plantation forest

The ownership of land used by farmers in establishing plantation forest was investigated and the results, presented in Table 6.

Table 4: Land acquisition method/ ownership

	Frequency n (%)
leasehold/ partnership	6 (4.4%)
Inherited	105 (77.8%)

Purchased	24 (17.8%)
Total	**135 (100.0%)**

Source: Field Survey, 2020

Osei-Tutu (2018) clarified that tenure security promotes sense of ownership in determining the capability of farmers in forest management. Ownership is one of the most influential assets that bring about an increase in the extent of forest cover in an area. From Table 6, a higher proportion (77.8%) of the entire sample population acquired the land in use by inheritance from deceased family members. The acquisition of such lands was by means of redistribution by family heads with the beneficiary as a member of the clan. Others especially the females also inherited it from their deceased husbands or relatives. The FAO (2002) investigated that, property right to land and labour forms the basis of production of food and other farming with tree planting not an exception.

Some of the respondents also purchased land for tree planting. This corresponds to Kanowski (1997) ascertion that the ownership of plantation forest is shifting from government to private/ local individuals. According to them, land price in areas close to human settlements as at the time they bought them (2018) was between GH₵ 1000 and GH₵ 1200 per acre whereas areas far way was between GH₵ 600 and GH₵ 800 per acre. Other respondents who bought theirs between 2010 and 2015 said they had an acre at GH₵ 200 but was far away from human settlement. Meanwhile, 4.4% obtained the land in the form of partnership with the owners of the land. These farmers have been given the land for a maximum of 50 years. According to the agreement, they cultivate on the land for 7 years and afterwards, the earnings from the land is divided into two for the tenants and the owners.

4.3.3 Tree planting system practiced in the study area

The various tree planting system carried out by respondents were identified and presented in Figure 4.

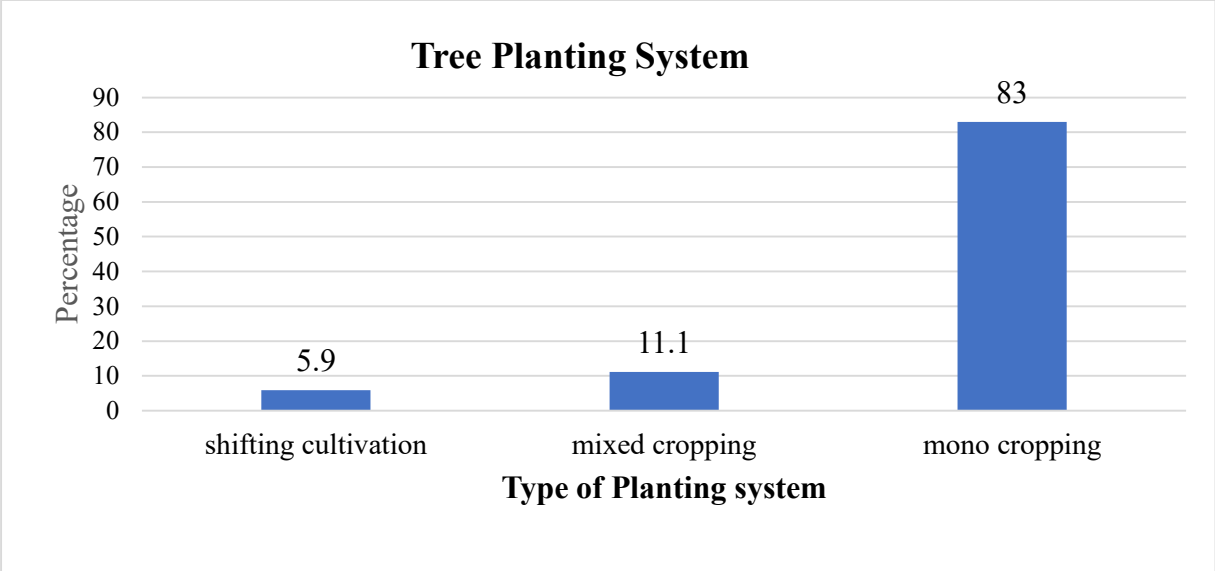

Figure 4: Tree planting system practiced by the farmers

Source: Field Survey, 2020

From Figure 4, a majority of the respondents (83%) practiced mono cropping where only trees are planted on a piece of land. As projected by Kanowski (1997), plantation forests is mostly established using monoculture systems to yield more wood products. Other respondents (11.1%) also practiced mixed cropping system where trees together with other crops are planted on the same piece of land. Most of these farmers planted crops together with trees for the first three years and then harvested the crops leaving the trees to mature. The respondents attested to it that they obtain high returns aside wood product. This confirms Rai and Schmerbeck (2012) allegation that mixed cropping is better than that of mono cropping. Only a few people (5.9%) practiced land rotation and bush fallow by leaving lands to fallow after harvesting trees. These farmers normally used inherited lands in practicing this type of system.

This confirms Osei-Mainoo (2012) findings that, high demand of land due to population growth has affected the practice of land rotation system

4.3.4 Alternate livelihood activities of farmers in Plantation forest

The study sought to know the alternate livelihoods activities of farmers who has established plantation forest. This is presented in Table 4.

Table 5: Alternate livelihood activities of farmers

	Frequency n (%)
crop farming	77 (57%)
livestock farming	1 (0.7%)
cash crop farming	34 (25.2%)
Other	23 (17.0%)
Total	**135 (100.0%)**

Source: Field Survey, 2020

Table 4 presents results on the livelihood activities farmers do apart from tree planting. From the table, 57% and 25.2% of the respondent were into crop farming and cash crop farming respectively. This confirms that the study area is a farming community as was reported by Osei-Mainoo (2012), where 85% of farmers in Ashanti region engaged in food crop and cash crop farming. Moreover, according to the 2010 census, about 78.8% of the people in the study area were into agriculture especially, crop farming (Ghana Statistical Service, 2014).The main crops planted are maize, cassava, yam and plantain. Almost all these farmers also plant vegetables with the common one as tomatoes. Example of the cash crops planted are cashew and cocoa.

Other activities farmers were teaching, artisanry and health workers. Most often, a few of the rural folks are into non – farming activities because of the intensification of agricultural land use (Oduro, Mohren, Pena-Claros, Kyereh and Arts, 2015). This reflected in the study area where 17% of the respondents (seen in Table 4) engaged in other activities such as trading, electrician, teaching, timber contracting, military personnel, driving, masonry, health worker, nursery supplier and carpentry.

4.3.5 Tree species used in establishing Plantation forest

The various tree species used by farmers in establishing their forest were asked and presented in Table 7. Also, in Plate 1, the researcher confirmed the information given by respondents on the type of tree species planted on their farms.

Table 6: Types of trees being planted

	Frequency n (%)
Teak	110 (81.5%)
Teak & Cedrela	7 (5.2%)
Teak & Oframo	4 (3%)
Teak & Ceiba	1 (0.7%)
Teak, Mahogany & Wawa	2 (1.5%)
Teak and Others	11 (8.1%)
Total	**135 (100.0%)**

Source: Field Survey, 2020

In Table 7, all the respondents were found to have planted Teak. According to the respondents, Teak is fire resistant and takes relatively shorter period (between 15 and 20 years) to mature. This affirms a study by Tufuor (2012) that Tectona grandis (Teak) is the leading species in Ghana's plantation forest. Bosu and Apetorgbor (2009) also agreed that Teak is the most dominant tree species among plantation forest in Ghana. However, it contradicted Asare-Kissiedu (2014) findings

that Cedrela was the most frequently grown species in forest reserves. More so, 81.5% of the respondents have planted only Teak because it flourishes on diverse forms of soil, hilly and undulating surfaces (Form International, 2013). Also, to them, Teak brings a high economic return compared to others which has led to its high preference.

Furthermore, 15.6% of the respondents had planted between two to four species which involved the mixture of both exotic and indigenous species. Apart from, Teak, Cedrela was the next exotic tree planted in the study area. According to Bosu and Apetorgbor (2009), planting of exotic species was a means to curtail pest in planted forests since pest frequently affected indigenous species like Mahogany, Odum and Kokrodua in Ghana. Again, the indigenous species such as Wawa, Odum, Emire etc. were commonly planted in the study area because it takes longer time to mature unlike the exotic ones.

Plate 1: Determining the various tree species planted at Akumadan

Source: Field Survey, 2020

4.4 Forest Cover Change Analysis

4.4.1 Land-Use/Land Cover (LULC) Classification

Table 8 exhibits the distribution of LULC classes of the study area within the years under review. The LULC maps for 1990, 2015 and 2020 were classified using the

supervised remotely sensed images. These maps yielded five land cover classes which are forested areas, farm lands, bare areas, built up areas and water bodies. The study was limited to the Off-reserves in the Offinso North District.

Table 7: Land cover class distribution for 1990, 2015 and 2020

LAND COVER CLASS	TOTAL AREA (ha)	FOREST RESERVE (ha)	OFF-RESERVE (ha)
	1990		
FORESTED AREAS	7643.34	4267.98	3375.36
FARM LANDS	44411.7	11580.5	32831.2
BARE AREAS	23009.8	11001.6	12008.2
BUILT UP AREAS	19831	11892.6	7938.4
	2015		
FORESTED AREAS	13338.6	7570.96	5767.64
FARM LANDS	58852.1	24448	34404.1
BARE AREAS	21455.4	6754.01	14701.39
BUILT UP AREAS	1082.05	255.308	826.742
	2020		
FORESTED AREAS	34083.7	17968.6	16115.1
FARM LANDS	52879.9	18745.8	34134.1
BARE AREAS	1348.43	330.863	1017.567
BUILT UP AREAS	4495.95	1318.03	3177.92
WATER BODIES	1920.24	665.01	1255.23

Source: Field Survey, 2020

From the study, farm lands covered greater portion of the land. This affirms the response from the respondents where majority (82.2%) is into crop and cash crop farming aside tree planting. Again, a report on the composite budget of the Offinso North District (2016) showed that agriculture precisely food crop employs over 80% of the people in the district. With this, the study area is characterized as a farming community. Nevertheless, forested areas among the other classes increased significantly from 7643.34 ha to 34083.7 ha within the three decades. This increase was influenced by the reforestation and afforestation activities practiced in the study. Most of local people gave up bare areas for tree planting. Water bodies covered very little portion in the study area.

This LULC class was not visible in 1990 and 2015 because the spectral band for water bodies was the same as that of bare areas per the Landsat images taken.

4.4.2 LULC at the Off-Reserve

The area of the Off-reserves was calculated by deducting that of forest reserve from the total area for each LULC class. This is represented in Figure 5.

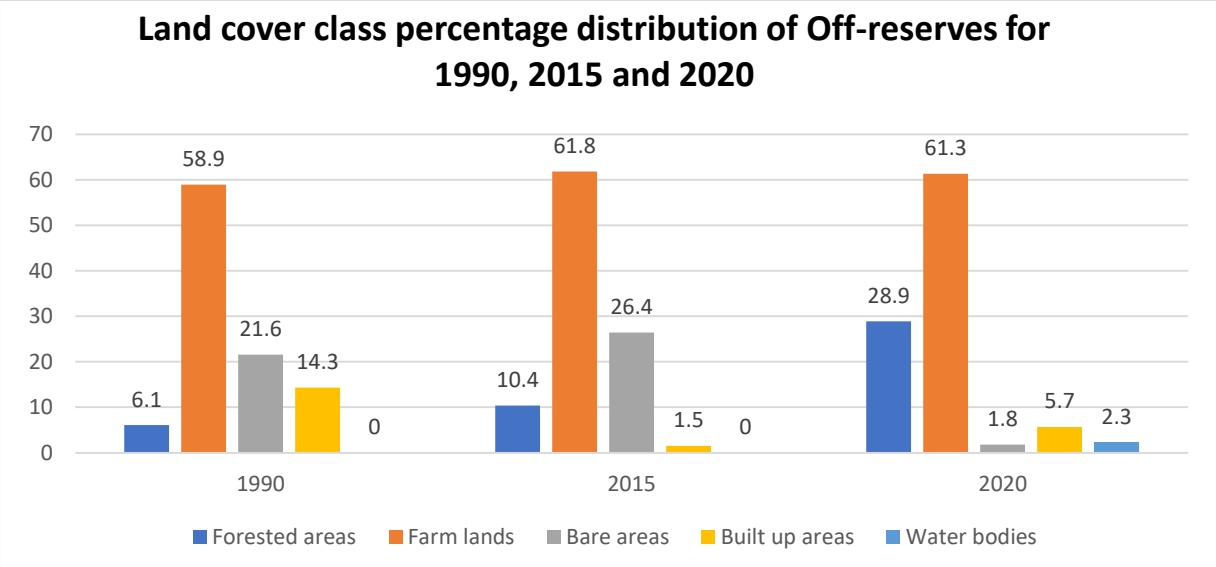

Figure 5:Land cover class percentage distribution of Off-reserves for 1990, 2015 and 2020

Source: Field Survey, 2020

From Figure 5, the dominant land cover feature was farm lands which covered 32831.2 ha (58.9%) in 1990. It was followed by bare areas representing 12008.2 ha (21.6%). According to the respondents most of these lands were left to fallow or prepared to be used for planting crops. Also, greater portion had experienced bush and wild fires. This also resulted in forested areas recording the least of 3375.36 ha (6.1%). This was attributed to the high rate of deforestation Ghana experienced since 1970's where about 5.2 million ha of forest cover were lost (Osumanu and Ayamga, 2017). It also affirms Van and Azomahou (2007) assertion that forest in developing countries

were deforested and had not yet focused on practicing forest decentralization. In 2015, despite the net loss of forest cover of 2.0% in the early 21st century in Ghana (FAO, 2006), the forested areas in the study area had increased to 10.4%. This was due to the practice of afforestation and reforestation in greater portion of degraded forest in the district. FAO (2012) declared that 78 million ha out of 130 million ha of forest loss was reclaimed between 2000 and 2010 through plantation forests in the world. The increase in forested areas is also attributed to the implementation of the forest and wildlife policy in 1994 (Asare-Kissiedu, 2014). The policy also brought about forest decentralisation where local people were considered in managing forest resources. There was also the implementation of National Plantation Development Programme (NFPDP) such as Modified Taungya System (MTS) and Private timber tree plantations. By the end of 2010, a total plantation of 146,186 ha was established under NFPDP in Ghana (Oduro, Mohren, Pena-Claros, Kyereh & Arts, 2015).

Again, in 2015, bare areas increased from21.6% (12008.2 ha) to 26.4% (14701.39 ha) at the expense of built up areas which reduced substantially from 14.3% (7938.4 ha) to 1.5% (826.742 ha). Most of the built-up areas including houses have been demolished because it was made of inferior materials such as mud to be replaced by concrete ones. However, the reverse occurred between 2015 and 2020 where bare areas significantly reduced to 1.8% whereas built up areas increased to 5.7% (3177.92 ha). The increase in built up areas was as a result of the increase in infrastructural development by the provision of amenities such as school, market centers, shops and accommodation. Furthermore, in 2020, there was a significant increase of forested areas from 6.1% to 28.9% representing 16115.1 ha (28.9%). The astonishing growth of teak especially in the first three years attracted people into planting trees (Onyekwelu and Yirdaw, 2006).

Most of the farmers then ventured into tree planting for its economic means hence, brought about an increase in forest cover. A respondent (Y.A from Akumadan) said that;

> *I am a farmer and a business man so I only invest in what I will get a greater return. The cost of timber as poles was more than GH₵100 in 2015.*

In all, the results for this study opposes Nair and Tieguhong (2004) assertion that agricultural expansion leads to fall in the forest cover of an area.

4.4.3 LULC maps of Offinso North district for 1990, 2015 AND 2020

The land cover maps of Offinso North district showing the land cover classes in 1990, 2015 and 2020 are displayed in Figure 6, 7 and 8 respectively.

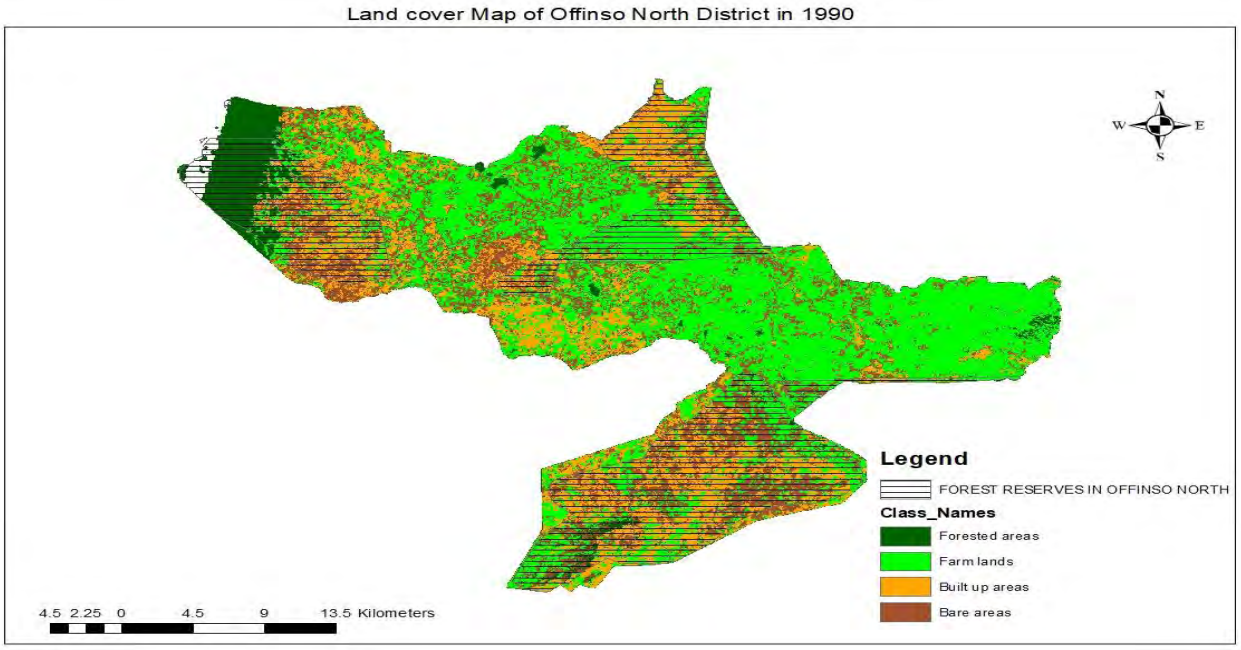

Figure 6: Land cover Maps for 1990

Source: Author's Construct from Landsat images

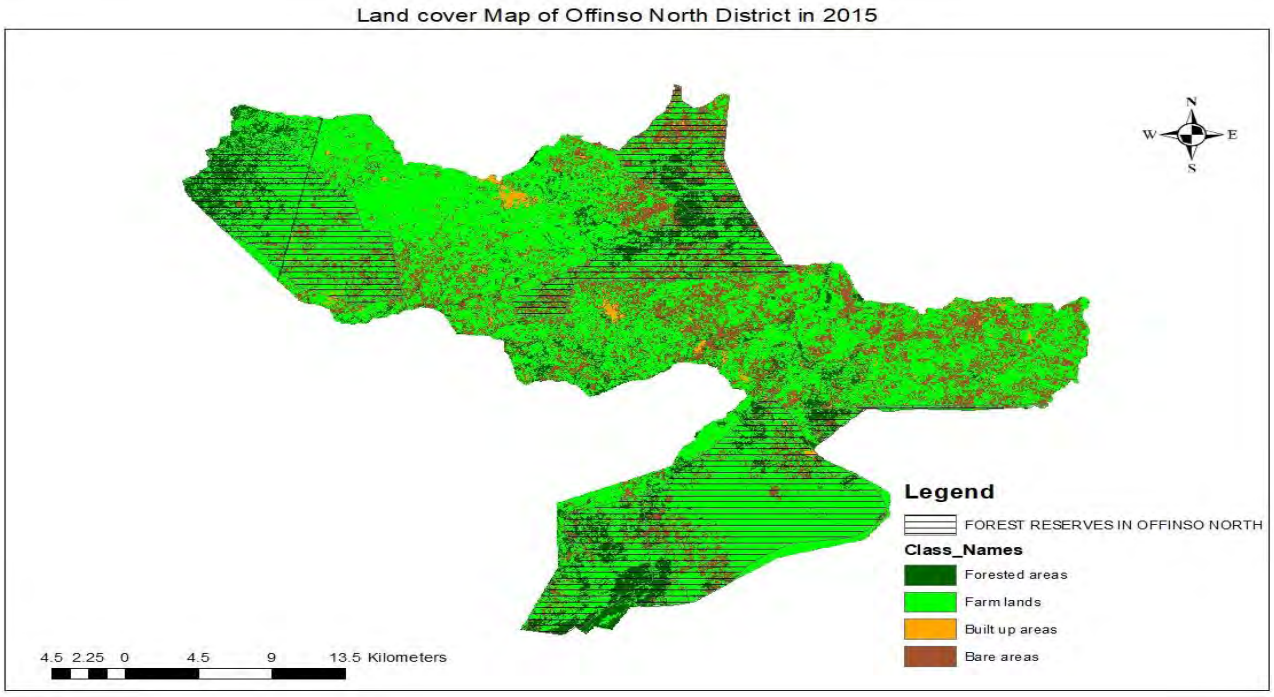

Figure 7: Land cover Maps for 2015

Source: Author's Construct from Landsat images

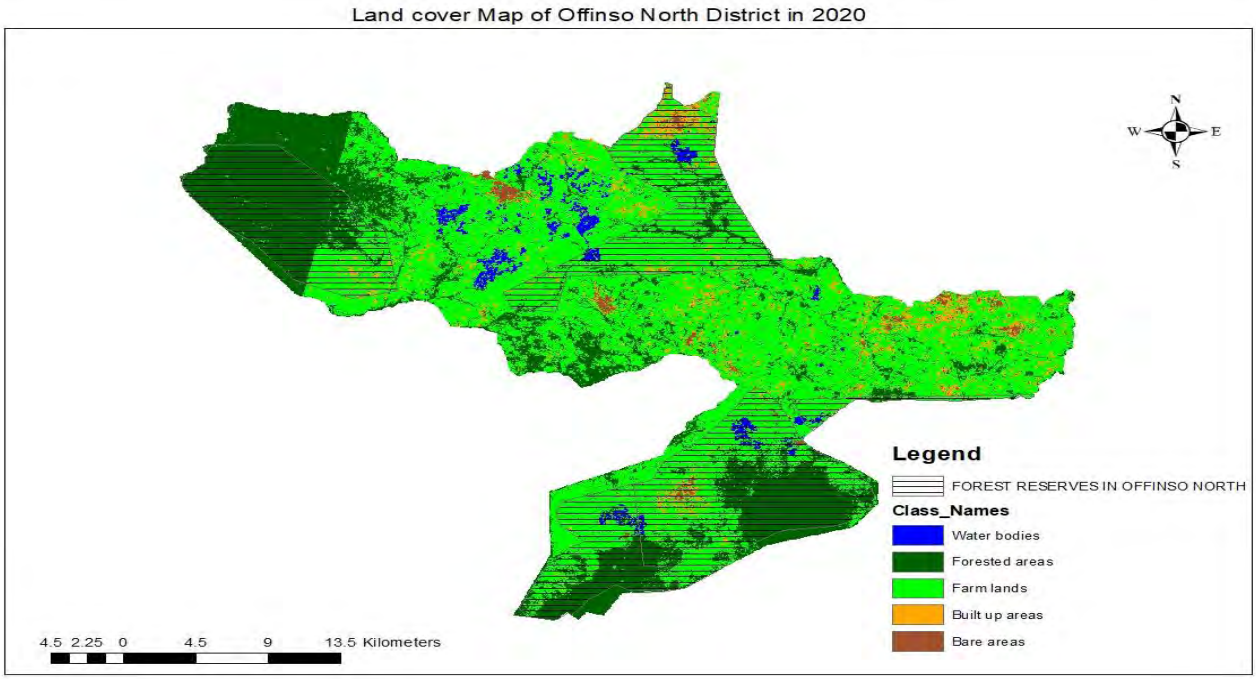

Figure 8: Land cover Maps for 2020

Source: Author's Construct from Landsat images

4.5 Land use/Land Cover change Distribution

Table 9 shows the various LULC classes in hectares that have changed into different LULC classes from 1990 to 2020. The study showed that the highest conversion was farm lands where 12666.8 ha were converted to forested areas between 2015 and 2020. This explains that farmers in plantation forestry in the study area had adopted the strategy of tree planting in CBF. With this strategy, food crops are planted between trees for the first three years and after the cultivation of crops the area turns into a forested area. As commented by Nair (1993), the practice of tree planting initially had its purpose to sustain food production. It can be said that trees of about 12666.8 ha had just been planted together with crops as at 2015. Hence the spectral band of trees having the same height of the crops was captured as that of farm lands. Also, from Table 9, the least conversion occurred within 2015 to 2020 where 0.88 ha of built up areas had changed to water bodies. Farm areas were very distant from human settlement with no water bodies available and so farmers used abandoned structures in their farms to store water for use. T.T (from Afrancho) commented that;

> *I have stored water in my farm so I do not often carry water from the house there unless it had not rain for quite a long time.*

Again, 54.27 ha of built up areas transformed into forested areas. This accounted for the increase in the forest cover to 28.9% in 2020 amidst the increase in population in the study area. Ghana Statistical Service (2019) projected that at a growth rate of 2.19 %, the population of Offinso North District had increased from 56881 to 68947. However, it contradicts Osei-Mainoo (2012) assertion that increase in population becomes a threat to forest cover as they are converted to farm lands and built up areas to meet the high demand for food and accommodation.

Table 8: Land conversions in the Off-reserves in Offinso North District from 1990 to 2020

Landcover class from	Landcover class to	1990 -2015 (Area in ha)	2015-2020 (Area in ha)	1990-2020 (Area in ha)
Forested areas				
	Farm lands	2456.42	3595.77	820.67
	Bare areas	178.94	7.86	233.26
	Built up areas	22.5	19.42	104.90
	Water bodies	-	164.93	22.12
Farm lands				
	Forested areas	2272.14	12666.8	6863.4
	Bare areas	2561.83	148.21	674.62
	Built up areas	82.96	688.82	2413.94
	Water bodies	-	388.46	748.76
Bare areas				
	Forested areas	1582.11	1464.57	3474.47
	Farm lands	7348.09	4504.16	7543.76
	Built up areas	60.59	563.94	514.51
	Water bodies	-	110.75	368.87
Built up areas				
	Forested areas	1886.56	54.27	3958.17
	Farm lands	7856.59	90.11	3682.06
	Bare areas	2035.98	64.19	9.408
	Water bodies	-	0.88	115.49

Source: Field Survey, 2020

Also, forested areas of 233.26 ha changed into bare areas between 1990 and 2020. Trees in these forested areas have just been harvested leaving those portions bare. This confirms FAO (2012) report that, 10% of the total forested areas (75 million ha) as at 2010 in Africa had been converted into other land cover types most especially, bare areas. Greater portion of forested areas (3595.77 ha) was converted to farm lands between 2015 and 2020. Thus, people had given up their lands for cash crop farming. This was consistent from observation that most of the lands have now been used for crop and cash crop farming instead of trees. Mr. KE (from Akumadan) commented that;

I have cleared almost all my trees for cashew farming because I earn more from cashew plant than planting trees which takes longer time to mature.

Water bodies did not convert to other land cover types because it became visible in the study area only in 2020. The images captured in 1990 and 2015 were in the dry season where trees along streams have been degraded exposing the streams to high rate of evaporation. Form International (2013) in their report stated that most of the water bodies present in forested areas in Ghana have greatly been affected by the severe decrease in water volume through forest degradation.

4.5.1 Overlay LULC Maps for 1990 – 2015, 2015 – 2020 AND 1990 – 2020

The overlay LULC maps shows the land conversion from one land cover class to another and the portions within the various land cover classes that had no change. The overlay LULC maps for 1990 – 2015, 2015 – 2020 and 1990 – 2020 are presented in Figure 10, 11 and 12 respectively.

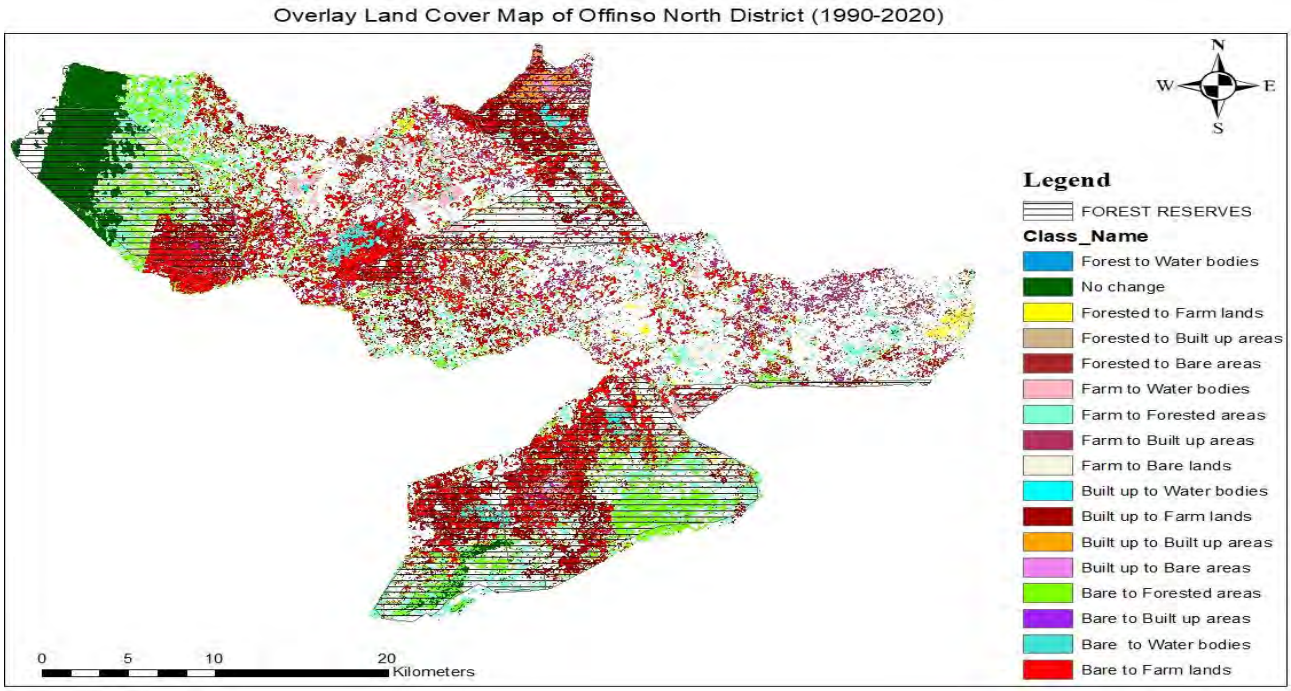

Figure 9: Overlay Land cover Maps between 1990 – 2015

Source: Author's Construct from Landsat images

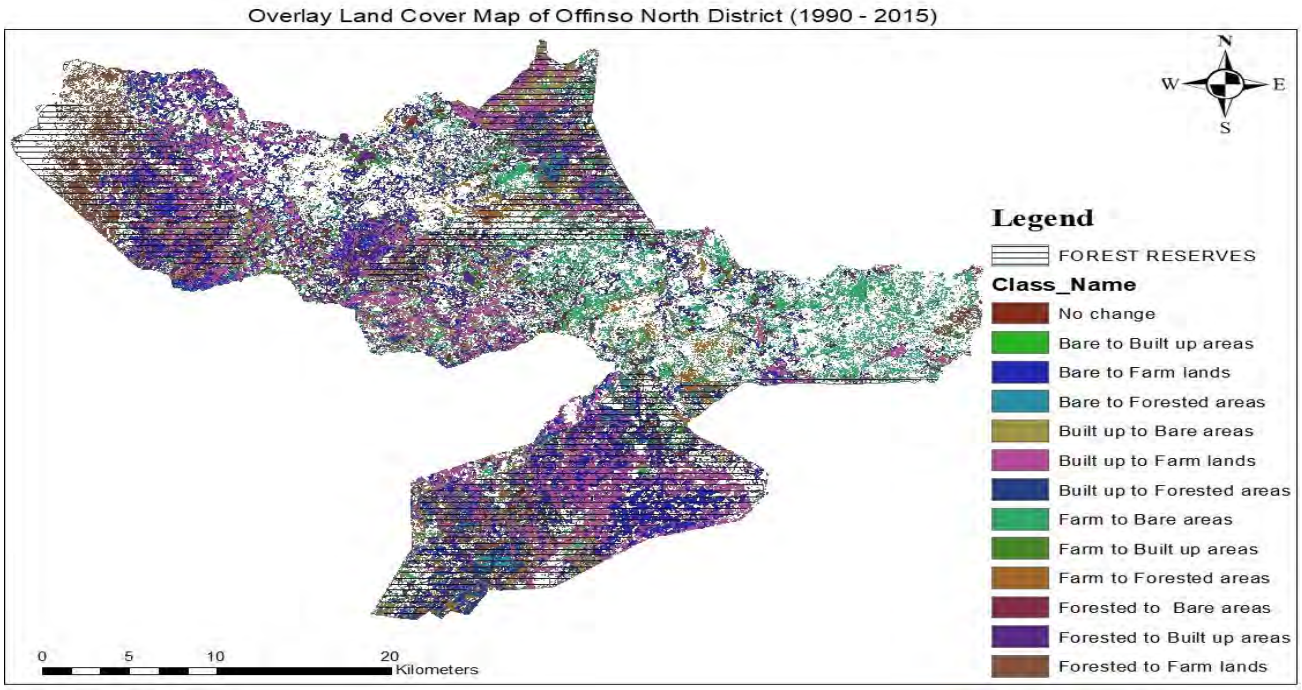

Figure 10: Overlay Land cover Maps between 2015 – 2020

Source: Author's Construct from Landsat images

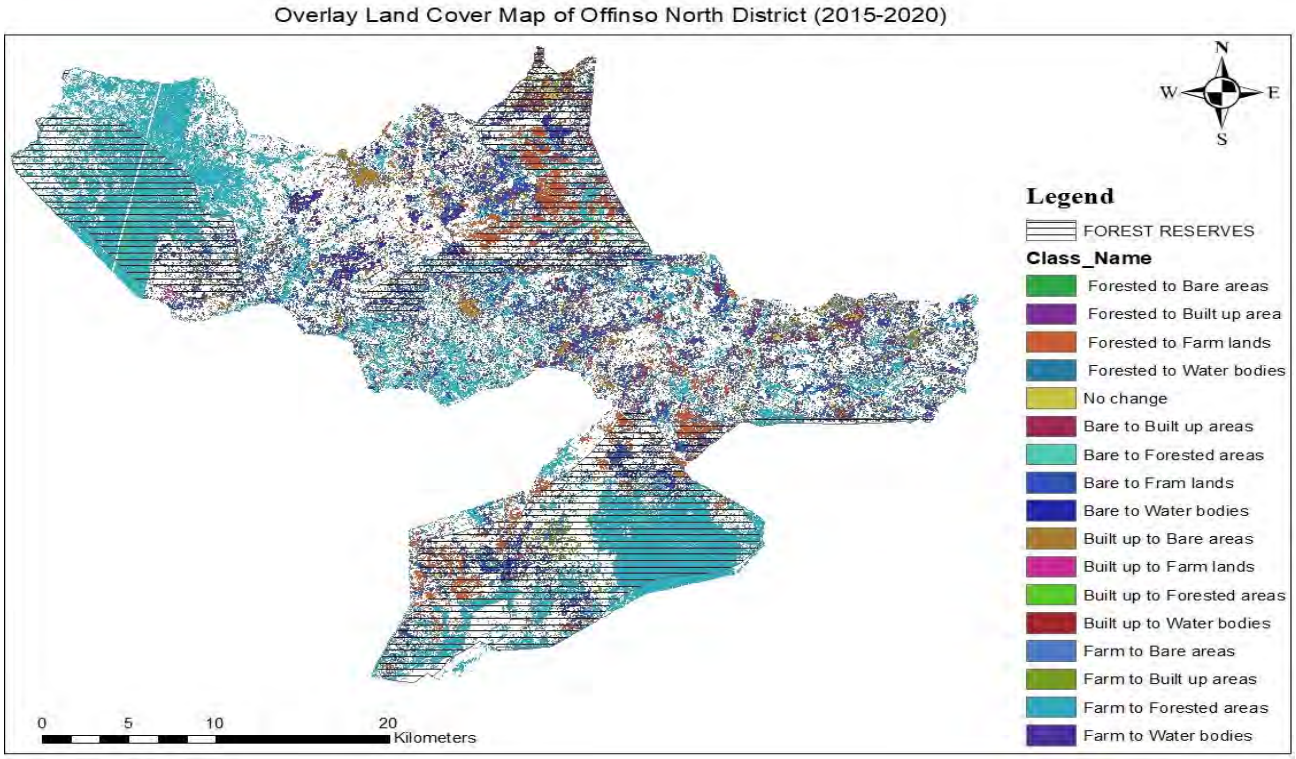

Figure 11: Overlay Land cover Maps between 1990 – 2020

Source: Author's Construct from Landsat images

4.6 Accuracy Assessment

Table 9: Accuracy Assessment of land cover maps of 1990, 2015 and 2020

Land cover class	Reference Name	Classified Total	Number Correct	Producers Accuracy	Users Accuracy
Forested areas	5	7	5	100.00%	**71.43%**
Farm lands	41	40	38	92.68%	**95.00%**
Bare areas	24	21	19	79.17%	**90.48%**
Built up areas	15	17	13	86.67%	**76.47%**
Overall Kappa Statistics = 0.8226					
Overall Classification Accuracy =			**88.24%**		
2015					
Forested areas	16	12	12	75.00%	**100.00%**
Farm lands	46	50	44	95.65%	**88.00%**
Bare areas	16	19	16	100.00%	**84.21%**
Built up areas	4	1	1	25.00%	**100.00%**
Overall Kappa Statistics = 0.8119					
Overall Classification Accuracy =			**89.02%**		
2020					
Forested areas	26	35	26	100.00%	**74.29%**
Farm lands	48	54	46	95.83%	**85.19%**
Bare areas	3	1	1	33.33%	**100.00%**
Built up areas	13	5	5	38.46%	**100.00%**
Water bodies	6	1	1	16.67%	**100.00%**
Overall Kappa Statistics = 0.7106					
Overall Classification Accuracy =			**82.29%**		

Source: Field Survey, 2020

Accuracy assessments were performed using confusion matrix for the supervised images of 1990, 2015 and 2020. From Table 10, the least overall accuracy for each image was 82%. This showed that most of the classified pixels corresponded to the data obtained from ground truth data (Peacock, 2014). Apart from the overall accuracy, maps were thoroughly assessed using Kappa coefficient, user accuracy and producer accuracy (Rwanga and Ndambuki, 2017). The difference between the user and producer accuracies determine how that land cover class was assumed to be other land cover types (Peacock, 2014). Farm lands remained the most reliable land cover class among the years because it was the dominant class and it recorded the least difference between producer and user accuracy which was 2.32% (that is 95% – 92.68%). Very few areas of farm lands were mistaken to be other classes.

Furthermore, user accuracy for the study was between 71% - 95% in 1990, 84% - 100% in 2015 and 74% - 100% in 2020. All the land cover type with 100% user accuracy such as forested and built up areas in 2015 were more reliable than the other land cover types in that same year. However, forested areas in 1990 weren't as reliable as in 2015 because it had a user accuracy of 71.43%. This was because of the unclear Google earth image of the study area in 1990 which made it difficult distinguishing farm lands from forested areas. Most of the farmers by then had just began tree planting hence trees had not grown to form canopies. From the field, these were farmers who had planted trees between 30 to 40 years. Also, the producer accuracy ranged from 79% to 100% in 1990, 25% to 100% in 2015 and 16% to 100% in 2020. Most of the open spaces at the middle of traditional compound houses were classified as bare areas. From field observation, most of the houses in the district had those traditional compound houses.

Lastly, the Kappa coefficients for the land cover maps in 1990, 2015 and 2020 were 0.8226, 0.8119 and 0.7106 respectively. These values proved that the land cover maps were substantial to determine the extent of forest cover in the study area. It corresponded to a study by Rwanga and Ndambuki (2017), whose overall Kappa coefficient was considered as significant with a value of 0.722.

4.7 Effects of Anthropogenic and Natural activities on Plantation Forest

Anthropogenic and natural activities have affected the establishment of plantation forest in the study area. Results from the farmers' perspectives on tree planting, bush fires, illegal logging and invasive species are presented in the Tables 11 to14.

4.7.1 Tree planting and its effects on Plantation forest

Tree planting positively affects the forest cover of an area. Respondents' were asked on their input to forest cover through planting of trees over the years. Their responses are presented in Table 11.

Table 10: Increase in tree planting in Plantation Forest

	Frequency (n)	Percent (%)
Highly agree	24	17.8
Agree	64	47.4
Disagree	39	28.9
Highly disagree	8	5.9
Total	**135**	**100.0**

Source: Field Survey, 2020

From Table 11, a few respondents (17.8%) extremely agreed that they have constantly increased tree species since they began plantation forest. Examples of such plantation forest among the selected communities are shown in Plate 2. Such farmers have acquired other lands to expand their forest. These were famers and timber

contractors who planted trees for economic benefits and as future investment. This agrees with Osei-Tutu (2018) findings that ownership of forest areas influences one to plant more trees for economic benefits landowners.

Majority (47.4%) of the entire sample population agreed that they have ensured that harvested trees have been replaced to maintain the number of trees per an acre (600 trees). Nevertheless, 34.8% disagreed to the increase in tree species on their farms. Most of these farmers have cleared parts of their plantation forest for cash crop farming especially cashew. They complained that they earn little from trees planted as compared to cash crop farming.

Plate 2:Plantation forest in Akumadan, Nkenkaasu, Nkwaakwaa and Afrancho

Source: Field survey, 2020

4.7.2 Bush fires and its effects on Plantation forest

The occurrence of bush fires in respondents' established forest was inquired since they began tree planting. This information focused on the decrease in bush fires and it is presented in Table 12.

Table 12: Decrease in Bush fires in Plantation Forest

	Frequency (n)	Percent (%)
highly agree	19	14.1
Agree	47	34.8
Disagree	48	35.6
highly disagree	20	14.8
no idea	1	0.7
Total	**135**	**100.0**

Source: Field Survey, 2020

In terms of the frequency of bush fires, majority (35.6%) of the respondents disagreed that they have recorded low degree of bush fires. A respondent (A.M from Nkenkaasu) bitterly commented that;

> *Farms close to mine are mostly caught up with fire anytime they do slash and burn activities and such fires always extend to my farms delaying the growth of trees I planted 10 years ago.*

Though Teak is fire resistant (Form International, 2013), its width and growth are affected with bush fires. Also, trees at a very young stage die off when caught with fire. Meanwhile, 34.8% agreed that there has been a reduction in the amount of indiscriminate bush fires. To these farmers they have experience bush fires in a very long time because they frequently do fire belt around their farms to protect trees. As reported by Form International (2013), fire belts regulate the spread of fire among tree plantations in Offinso North District. Some farmers (14.8%) reported that, their farms have never caught fire since they began farming. Only 0.7% had no idea whether there is high or low rate of the occurrence of bush fires in the study area. Farmers who

reported that bushfires were scarce were those above 80 years (6.7%) who hardly go to the farms.

4.7.3 Illegal logging and its effects on Plantation forest

Farmers consent on illegal logging in their established forest was sought for and presented in Table 13.

Table 13: Decrease in illegal logging in Plantation forest cover

	Frequency (n)	Percent (%)
highly agree	52	38.5
Agree	39	28.9
Disagree	36	26.7
highly disagree	8	5.9
Total	**135**	**100.0**

Source: Field Survey, 2020

From the present study, majority of the farmers 38.5% consented that there is decrease in illegal logging in their plantation forests. These farmers have put measures in place to protect their forest even in their absence. Examples of such measures include setting spies to guard it, putting up cottage in the farms and tying red flags on trees that are at prone areas to be stolen. Examples of such cottages are seen in Plate 3. A respondent (L.O from Akumadan) said that;

> *I have employed someone staying in the farm to protect my trees from being stolen and people caught stealing trees are arrested.*

This confirms Osei-Tutu (2018) report that establishment of forest by local farmers forest has led to forest sustainability as a result of the low indiscriminate felling of trees. It also validates the assertion that private owned forest recorded the least in terms of illegal logging activities compared with forest reserves under state ownership (Ampofo

et al., 2015). Moreover, about one third of the farmers (32.6%) disagreed that there is low rate of illegal logging. To them, they have tried all efforts in protecting their forests yet their trees are stolen mostly at midnight and in their absence.

Plate 3: Cottages that accommodate farmers who guard their trees at Akumadan

Source: Field Survey, 2020

4.4.4 Invasive species and its effects on Plantation forest

The study asked questions on the rate of invasive species among Plantation forest in the study area. The outcome is presented in Table 14.

Table 14: Decrease in invasive species in Plantation Forest

	Frequency (n)	Percent (%)
Highly agree	9	6.7
Agree	67	49.6
Disagree	20	14.8
Highly disagree	8	5.9
No idea	31	23.0
Total	**135**	**100.0**

Source: Field Survey, 2020

From the study, 49.6% agreed that there has been a decrease in invasive species in the study area which has improved the growth of trees in plantation forest. This is because to them, trees matured within their required number of years or even less. This affirms the assertion that the absence of invasive species promote plants regeneration

(Duah-Gyamfi et al., 2015). In addition, 23% of the respondents did not know whether there are invasive species on their farms or not. To them, any species that do not allow other tree species or crops to thrive are considered as invasive species even including Teak. This substantiates the findings of Mwihomeke et al. (2002) that foreign species like Cedrela odorata are invasive species which interrupt the growth of other tree species.

CHAPTER FIVE

BENEFITS AND CHALLENGES ASSOCIATED WITH PLANTATION FOREST

5.1 Introduction

This chapter presents results and discussion on the benefits of plantation forest in relation to biodiversity, wood products/ food crop and the socio-economic wellbeing of farmers. The chapter also elaborates on the correlation between a change in forest cover and the socio-economic wellbeing of farmers. Also, the challenges of farmers in plantation forest are discussed. Lastly, the chapter presents the empirical evidence of this study in relation to the conceptual framework.

5.2 Benefits of plantation forest in Offinso-North district

The study also investigated the benefits of plantation forest to farmers and the environment. Results are presented in the tables below.

5.2.1 Plantation forest and its impact on biodiversity

Respondents were asked the impact of plantation forest to biodiversity specifically the abiotic environment such as soil, water and the atmosphere. Their responses are presented in Table 15.

Table 11: Plantation forest improves biodiversity

	Frequency (n)	Percent (%)
highly affective	29	21.5
Affective	104	77.0
not affective	1	0.7
highly not affective	1	0.7
Total	**135**	**100.0**

Source: Field Survey, 2020

A substantial majority, 77% of the respondents confirmed that planting of trees has a positive impact on biodiversity with 21.5% who highly agreed to this assertion. They said birds are sometimes seen making their habitat on the trees. They also said trees around streams reduces evaporation hence prevent rivers from drying up. Only 0.7% did not agree that planting of trees improves biodiversity. These were those who have intentionally destroyed trees because they do not earn from trees as they expected. Increasing in tree species has positively affected the climatic condition of the area. There has been a reduction in temperature as trees remove greenhouse gases from the atmosphere thus, trees function as a carbon sink (Geta, Nigatu and Animut, 2014). These farmers practice seasonal farming and solely rely on rainfall in their activities. Ansari (2003) also reported that, plantation forests have healthy influence on the environment because of the end product of photosynthesis which is oxygen.

5.2.2 Plantation forest and its impact on wood product and food crops

The role of plantation forest providing wood product such timber and food crops were sought from the respondent and this is presented in Table 16. Plate 4 also shows the various food crops cultivated from plantation forest.

Table 12: Plantation forest improves wood product and food crops

	Frequency (n)	Percent (%)
highly affective	15	11.1
Affective	110	81.5
not affective	10	7.4
Total	**135**	**100.0**

Source: Field Survey, 2020

From the sample population, 81.5% responded that planting of trees has improved food and wood product as seen in Table 16. To them trees provide them with timber for making furniture's and roofing their houses. Most of these farmers also said they plant crops (maize, groundnut, cassava and plantain) in between trees within the early 3 years. These trees prevent soil erosion that may destroy their crops. N.K (from Nkenkaasu) said that;

> *I have harvested about 10 bags of maize on the same land I have planted trees though the place is liable to flooding.*

Asare-kissiedu (2014) found out that MTS, a reforestation activity in degraded forest, contributed extensively to food production in Ghana. According to him, its effect improved farmers' well-being and alleviated poverty. However, 7.4% of the farmers doubted that, plantation forest has an effect on food production and raw materials and that trees are not beneficial to their families. Majority of these farmers have less than 2 acres of land for tree planting. Therefore, do not plant crops between the trees.

Plate 4: Teak plantation at the early stages together with groundnut, maize and cassava

Source: Field Survey, 2020

5.2.3 Plantation forest and its impact to income and poverty mitigation

Respondents' income level in relation to the income they have made on the sales of wood products obtained in their plantation forest was assessed and presented in Table

18. Also, Plate 5 indicates examples of wood products derived from respondents' plantation forest.

Table 13: Plantation forest improves income and mitigates poverty

	Frequency (n)	Percent (%)
highly affective	5	3.7
Affective	15	11.1
not affective	46	34.1
highly not affective	50	37.0
no idea	19	14.1
Total	**135**	**100.0**

Source: Field Survey, 2020

With regards to income from the sales of trees, 37% believed that planting of trees has not improved their income levels. This is because of the low prices of trees after a long period of maturity associated with frequent pruning and clearing of weeds. Tree planting only becomes attractive when it yields higher return than other farming activities as tree growing is characterized by longer maturity period and greater risks (Subasinghe, 2014)

Two respondents (Mr. B.O.T and Y.W, all from Akumadan) bitterly said that;

> *We are given as low as GH₵ 10 per tree after spending time pruning and doing fire belt to protect trees.*

Furthermore, 34.1% of the respondents' said their income level has deteriorated which has affected their quality of life. They commented on their difficulty in providing basic amenities for their families. The CESS-ODI (2005) reported that the income and non-income levels of villages and households in tree planting mostly tend to be worse off.

In their findings, it was revealed that rural households under the poverty line relies solely on forest income than those above. This has gradually affected their commitment in tree planting. Alcorn (2014) claimed that social and economic outcomes of trees determine tree sustainability. Therefore, the outcome influences man into planting more trees to begin the cycle.

Plate 5: Examples of Timber and other wood products from the plantation forests

Source: Field Survey, 2020

5.3 Correlational Analysis of the relation between change in forest cover and the socio-economic wellbeing.

The study analysed the correlation between the change in forest cover as a result of plantation forest and the socio-economic wellbeing of farmers. This is presented in Table 19.

Table 14: Correlational Analysis of the relation between change in forest cover and the socio-economic wellbeing of the farmers

Correlations

		Income from trees	Impact on poverty alleviation
Increase in forest cover	Pearson Correlation	-0.032	**0.237****
	Sig. (2-tailed)	0.711	**0.006**
	N	**135**	**135**

**. Correlation is significant at the 0.05 level (2-tailed).

Source: Field Survey, 2020

The positive change in forest cover was found to have a weak negative correlation (Pearson correlation = -0.032) with local farmer's income received from trees as seen in Table 19. However, this relation was seen to be statistically insignificant (*p*-value=0.711). The reason was that, the local farmers were unable to liaise with the timber contractors concerning the sales of trees. These contractors take into account the means of transporting harvested trees hence it affected the price of trees to as low as GH ₵10. From the study, 85.2% farmers (as seen in Figure 14) admitted that buyers/contractors harvest and transport the trees they buy. It could therefore be inferred that tree planting as an activity is profitable often at the expense of the farmers who plants them. Moreover, there was a statistically significant positive correlation between an increase in forest cover and the alleviation of poverty among farmers (*p*-value=0.006). The sales of NTFPs and timber has helped improved the standard of

living of farmers hence mitigating poverty in the study area. As suggested by Sunderlin and Ba (2005), NTFPs such as charcoal, fuelwood, medicinal herbs and roofs available in the study area has helped in alleviating poverty.

Nonetheless, a report by CESS-ODI (2005) presented positive correlation between rural poverty and forest cover with a strong correlation in areas with high forest cover and high rural poverty. Thus, increase in forest cover increases poverty and vice versa. This contradicts the findings of this study where an increase in forest cover mitigates poverty among local people.

5.4 Challenges associated with Plantation forest.

There have been various challenges militating against the smooth practices of plantation forest among farmers. This study assessed the responses of the respondent regarding some of the challenges they face in plantation forest. Results are presented in the tables and figures below.

5.4.1 Assistance given to people in Plantation forest

Respondent were asked a Yes/No question to know whether they have been assisted by government, private individuals or NGOs since they began establishing forest. This is presented in Table 20 and Figure 13.

Table 15: Support received from government, individuals or NGOs

	Frequency (n)	Percent (%)
Yes	8	5.9
No	127	94.1
Total	**135**	**100.0**

Source: Field Survey, 2020

From the present study, almost all the respondent (96%) protested of not receiving any assistance from government, individuals or NGOs. These farmers reported that they provided for themselves all that they needed both tools and materials.

This agrees to the findings by Chala (2010), that majority of farmers provided their own seedlings (by raising them) and other tools to be used.

Also, Figure 13 shows how the needed tools and materials are obtained by the farmers.

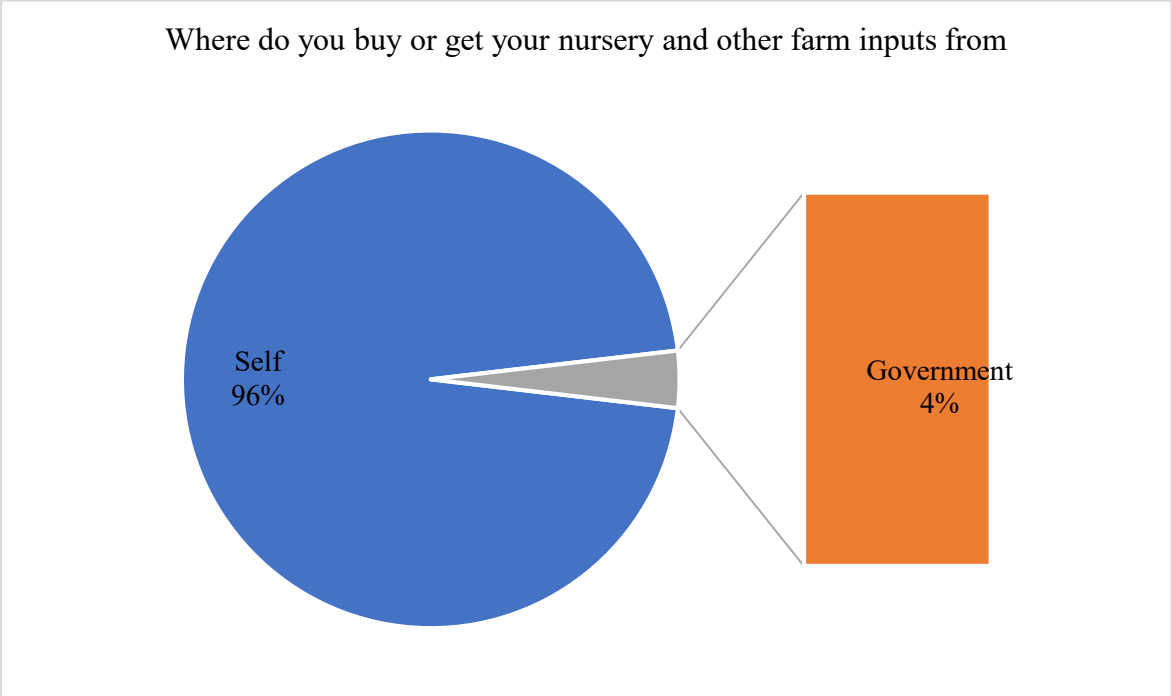

Figure 12: Source of nursery and other inputs for respondents

Source: Field Survey, 2020

In this present study, only 4 % responded that they have received support mostly in a form of seedlings from individuals and NGOs. Some of the PADO members also reported that the price of seedlings was subsidized and at times given freely by other members who are in nursery production. Also, very few of the farmers also had their colleagues assisting them in pruning and the making of fire belt. This confirms

Aggarwal (2006) discovery that, communities provide incentives themselves which is mostly inadequate in ensuring forest sustainability.

5.4.2 Transportation of trees from Plantation forest

Respondents were asked how they transport their harvested trees and it is presented in Figure 14.

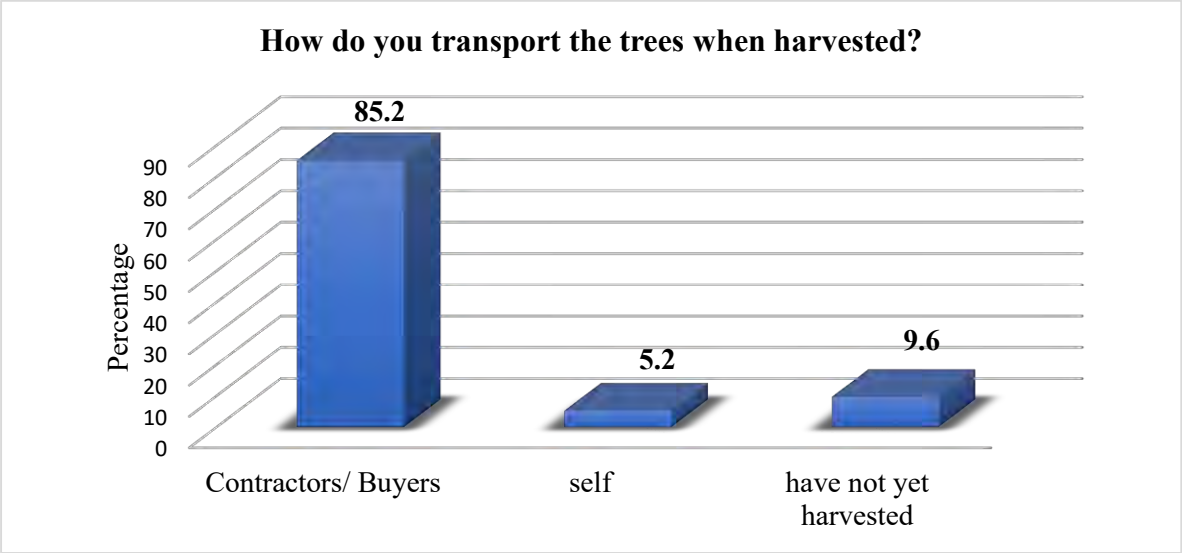

Figure 13: Transportation of harvested trees

Source: Field Survey, 2020

In the transportation of trees, 85.2 % said that buyers/ contractors harvested and conveyed them to their destination. Also, 5.2% respondents said that they transported the trees to the house by themselves. Most of these farmers use such trees in roofing their house and making furniture's. Nevertheless, some of the trees had not been harvested therefore, 9.6% of the respondents were not able to determine the means of transporting trees.

5.4.3 Challenges local farmers face in Plantation forest

Local farmers were interrogated on the main challenges they have encountered in Plantation forest. Results are presented in Table 21.

Table 16: Challenges local farmers face in Plantation forest

	Frequency (n)	Percent (%)
bush fires	5	3.7
capital intensive	19	14.1
no support or loans from government	51	37.7
low prices of trees	36	26.7
bureaucratic process in harvesting	4	3.0
Others	20	14.8
Total	**135**	**100.0**

Source: Field Survey, 2020

The major challenge most farmers (37.7%) faced in this study is not getting assistance even in the form of loans from government. These farmers admitted that plantation forest is capital intensive and needed help in carrying it out effectively. As commented by Mad. M.Y (from Nkenkaasu),

> *If not a PADO member, I would have destroyed my trees because it is not yielding me anything as my child has been worrying me to clear the teak for cashew plantation or leave the land bare.*

They complained that they are unable to use their forest as a collateral for loans from banks as compared to cocoa farmers. This is due to the variation in the maturity of trees compared to that of the cash crops. As a result of the long years of maturity of trees some of the farmers reported to have been weary and has destroyed almost all the trees to make the land available for other farming activities. Also, 26.7% of the respondent complained about the low prices they received on trees. Some of the farmers were paid

as low as GH ₵10 for a tree. Most of the timber companies buy trees at a very low price from the local farmers and at times may escape without settling their debt. Such companies also end up damaging other younger species while harvesting the sold ones. This confirms Osei-tutu (2018) assertion that communities exchange their rights to lumber companies at a very low price and defiled the forest alongside. With this, some of the farmers tried harvesting the trees themselves but could not succeed because of the bureaucratic process governing it.

Also, only 3.7% of the farmers complained of bush fires as a hindrance to their plantation forest. These are those who recorded that they experienced bush fire yearly, mostly as a result of the close proximity of their farms to other farms that perform slash and burn activities. It is therefore entreated that measures should be put in place to educate farmers on how to clear their lands using fire. Moreover, 14.8% of the farmers had other challenges such as no recognition of tree plantation farmers for national awards such as farmers' day. Another challenge is that government officials do not provide forest plantation funds to farmers as expected. Farmers do not also get income as carbon credit as foreign investors in afforestation do. This is because the local farmer's lands for afforestation are smaller than that of the foreign investors. However, these farmers have helped increased the forest cover in the district.

5.5 Summary of empirical evidence in relation to the conceptual framework

The findings of the study in relation to the conceptual framework is presented in Figure 15.

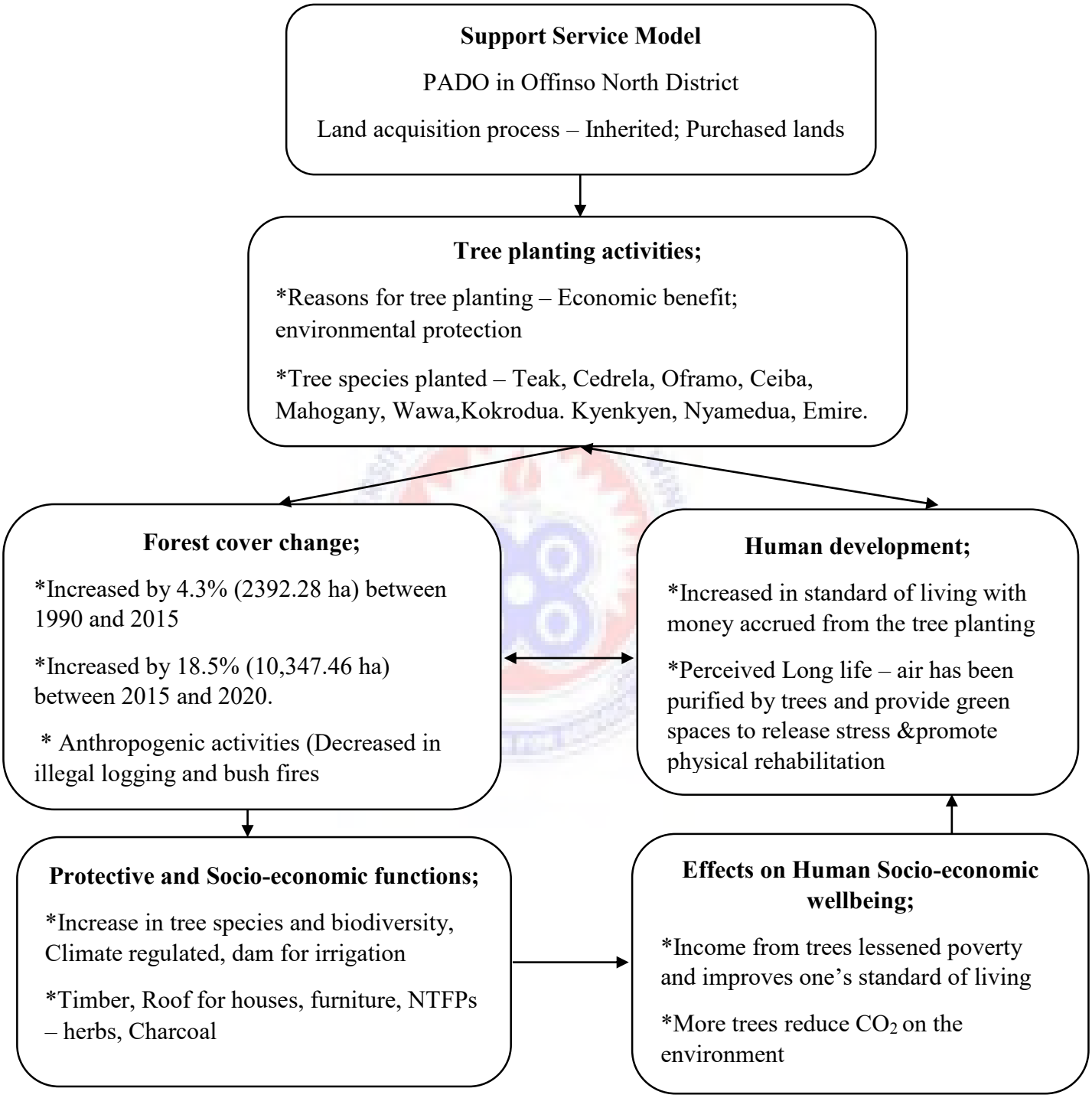

Figure 14: Framework on Human intervention in Tree Planting in Offinso North District

Source: Author's construct

In conclusion, a change in forest cover is influenced by tree planting activities by the local farmers in the study area with a high degree ownership to lands. Land is most influential asset in the establishment of tree planting in the district. As a result of the economic benefits farmers go into the establishment of plantation forest. The dominant tree species planted is Teak. Continuous planting of trees in the district increased tree species and biodiversity. This has regulated the climate in the area with trees serving as carbon sinks. Anthropogenic activities such factors such decrease in illegal logging and bushfires has sustained the expansion of forest cover in the district to 16115.1 ha in the year 2020.

In addition, trees also provide timber, wood products, NTFPs and income obtained from these products improved on the quality of life of the local farmers. Tress has also led to human development such as healthy living from green spaces, provision of shelter, shops and promoting education as student's are given free desk. The relationship between these systems (forest cover and human development) are interdependent and is maintained through the perpetual flow of forest trees hence the cycle of tree planting begins after matured trees are harvested.

CHAPTER SIX:

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter summarises the entire study and draws conclusions on it. The summary is done under these themes: local farmers motive in establishing plantation forest, the extent of plantation forest and its effect on forest cover, benefits and challenges associated with tree planting in Offinso North District. This chapter presents the major findings, concludes and make recommendations to this study.

6.2 Summary of Findings

The study revealed that plantation forest was established mainly for economic benefits from wood and wood products. A majority of the farmers (77.8%) used inherited lands from relatives for plantation forest. All farmers had alternate livelihood activities with the dominant as food crop and cash crop farming. Also, the respondents (83%) practiced mono cropping tree planting system. It was revealed that all farmers planted Teak. Furthermore, concerning the forest cover change analysis, the study indicated five land cover classes which are forested areas, farm lands, bare areas, built up areas and water bodies. Farm lands were the dominant class in the district, however forested areas had the highest expansion rate over the years under review (1990, 2015 and 2020). Also, plantation forest increased by 4.3% (2392.28 ha) between 1990 and 2015 and 18.5% (10,347.46 ha) between 2015 and 2020. From this study, greater portions of farm lands (12666.8 ha) converted into forested areas. Also, there has been a decrease in invasive species and illegal logging among plantation forest in the district.

In addition, the study showed that trees have improved biodiversity such as trees species, insects/birds and protected geophysical elements. Also, plantation forest

provides timber for wood processing industries and has improved food cultivation in the district. The study presented that income obtained from trees do not correspond to increase in forest cover in the study area. However, farmers' poverty and quality of life have been improved and thus, a change in forest cover improves their socio-economic wellbeing.

Lastly, results from this study showed that almost all the farmers (96%) have not received any assistance from government, individuals or NGOs. It was revealed that buyers/ contractors harvested and conveyed trees bought from the local farmers. Most of the farmers (37.7%) do not get assistance in a form of loans from government and has made them become weary in tree planting as it is capital intensive. Again, other problems associated with plantation forest are low prices of trees, long years of maturity and bush fires.

6.3 Conclusion

Forest resources in greater extend are non-excludable in ensuring human development. Though, most of the virgin forest have been altered, tree resources in many parts of the world has shifted from the natural to plantation forests. There has been various forest restoration and afforestation schemes implemented across the continent. This study particularly focused on plantation forest which is associated with the Support Service Model in the Offinso North district and how it has contributed to the forest cover in the area. The socio-economic benefits of trees have also improved the living condition of the rural folks. Most of these local farmers have become weary in sustaining tree planting because of the low prices of trees and not obtaining assistance from the government. Regardless of these challenges, very few farmers have extended their plantation forest and a quite number of them have had their standard of living improved. This implies that properly implemented measures such as increase in tree

prices and incentives to farmers in plantation forest will increase and sustain forest cover and farmer's socio-economic wellbeing. In all, continuous growth in forest cover despite the increase in population and high demand for wood and wood products can only be attained through the establishment of plantation forest.

6.4 Recommendation

From the findings, the following recommendations are made to ensure sustainable plantation forest in the study area.

- The government should intervene in setting prices of trees so to motivate farmers to constantly plant trees and effectively manage them.
- It is also recommended that the Forestry Commission should conduct a regular assessment of the forest cover in the study area in order to keep track of the changes over time.
- The application of GIS and remote sensing techniques used in the analysis of forest cover and land-use change should be encouraged. This helps in obtaining detailed information of the forest cover in an area which may not be derived through surveys.
- To ensure continuous planting of trees, government should assist farmers with loans, technical assistance and other incentives in plantation forest.
- Tree species with shorter period of maturity such as eucalyptus should be introduced to farmers to promote and sustain plantation forest.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE TO LOCAL FARMERS IN PLANTATION FOREST

The aim of this study is to investigate the involvement of members in PADO in forest plantation (afforestation) in Offinso North district. All information obtained from this study will remain confidential. Serial numbers instead of names will be used in this study for identification.

Study ID Number _____

SECTION A: DEMOGRAPHIC CHARACTERISTICS

A. Age _____ **B. Gender** Male ( ) Female ( )

C. Marital status Single ( ) Married ( ) Divorced ( ) Co-habitating ( ) Widowed ( )

D. Level of education

No formal education ( )
Primary education ( )
Junior high school ( )
Senior high school ( )
Tertiary education ( )

SECTION B: INVOLVEMENT IN AFFORESTATION

1. Is PADO well known in the District?

   a. Yes ( )
   b. No ( )
   c. I don't know ( )

2. Are you a member of PADO ? Yes ( ) No ( )

   If Yes, how did you join?

   a. Invitation by friend/relative ( )
   b. Heard about it on the information centre ( )
   c. Announcement at gatherings (durbar, church etc.) ( )
   d. Others (*please specify)* ……..

3. What intrigue you to indulge in tree planting?

   a. Economic benefits ( )
   b. Reduce deforestation ( )
   c. Preserve water bodies and biodiversity ( )
   d. Other (*please specify)* ( )

4. What tree planting system do you practice?

a. Shifting cultivation ( )
b. Mixed cropping ( )
c. Mono cropping ( )
d. Other (*please specify*) _____

5. Which of the following activities do you engage in apart from Tree planting?

   a. Crop Farming ( )
   b. Livestock Farming ( )
   c. Fish farming ( )
   d. Cash crop ( )
   e. Other (*please specify*) _____

6. a. For how long (in years) have you engaged in the planting of trees? _____ years.

   b. How many acres of land do you have?

7. How many species of trees do you plant?

One specie ☐ Two – Four species ☐ Five – Ten species ☐

More than Ten species ☐

8. Types of trees being planted and years of maturity (Please indicate all of them)

   _____

   _____

   _____

   _____

9. Land acquisition method/ ownership?

Leasehold/ Partnership ☐ Inherited ☐ Purchased ☐

Other (*please specify*) _____

10. If leased, for how many years _____ and how many years left? _____years

SECTION B: CONTRIBUTION OF AFFORESTATION BY INDIVIDUALS TO THE EXTENT OF FOREST COVER

To what extent do you agree to the following assertions

	Highly agree	Agree	Disagree	Highly disagree	No idea
Increase in tree species since I began planting	☐	☐	☐	☐	☐
Decrease in invasive species	☐	☐	☐	☐	☐
Low rate of bush fires	☐	☐	☐	☐	☐
Decrease in illegal logging	☐	☐	☐	☐	☐

SECTION C: BENEFITS OBTAINED FROM AFFORESTATION

On a scale of 1 to 5, to what extent does planting of trees affect humans and the environment as a whole?

Please respond to the following as it applies to you

	Highly affective	Affective	Not affective	Highly not affective	No idea
Impact on the environment					
Biodiversity (Plants, Birds, Aquatic life)	☐	☐	☐	☐	☐
Food and raw materials	☐	☐	☐	☐	☐
Climate	☐	☐	☐	☐	☐

Impact on humans					
Income from trees	☐	☐	☐	☐	☐
Poverty alleviation	☐	☐	☐	☐	☐
Improved quality of life	☐	☐	☐	☐	☐
Other (please specify)					

SECTION D: CHALLENGES INDIVIDUAL ENCOUNTER IN PRACTICING AFFORESTATION AND ITS IMPLICATIONS TO FOREST SUSTAINABILITY.

1. Do you receive any support from government, individuals or NGOs? Yes ( ) No ( )
2. Where do you buy or get your nursery and other farm inputs from? _____
3. How do you transport the trees when harvested? _____
4. What are the challenges you face in tree planting? _____

_____

5. For how long has the challenge been there?

Less than a year ☐ More than a year ☐ Less than 10 years ☐ More than 10 years ☐

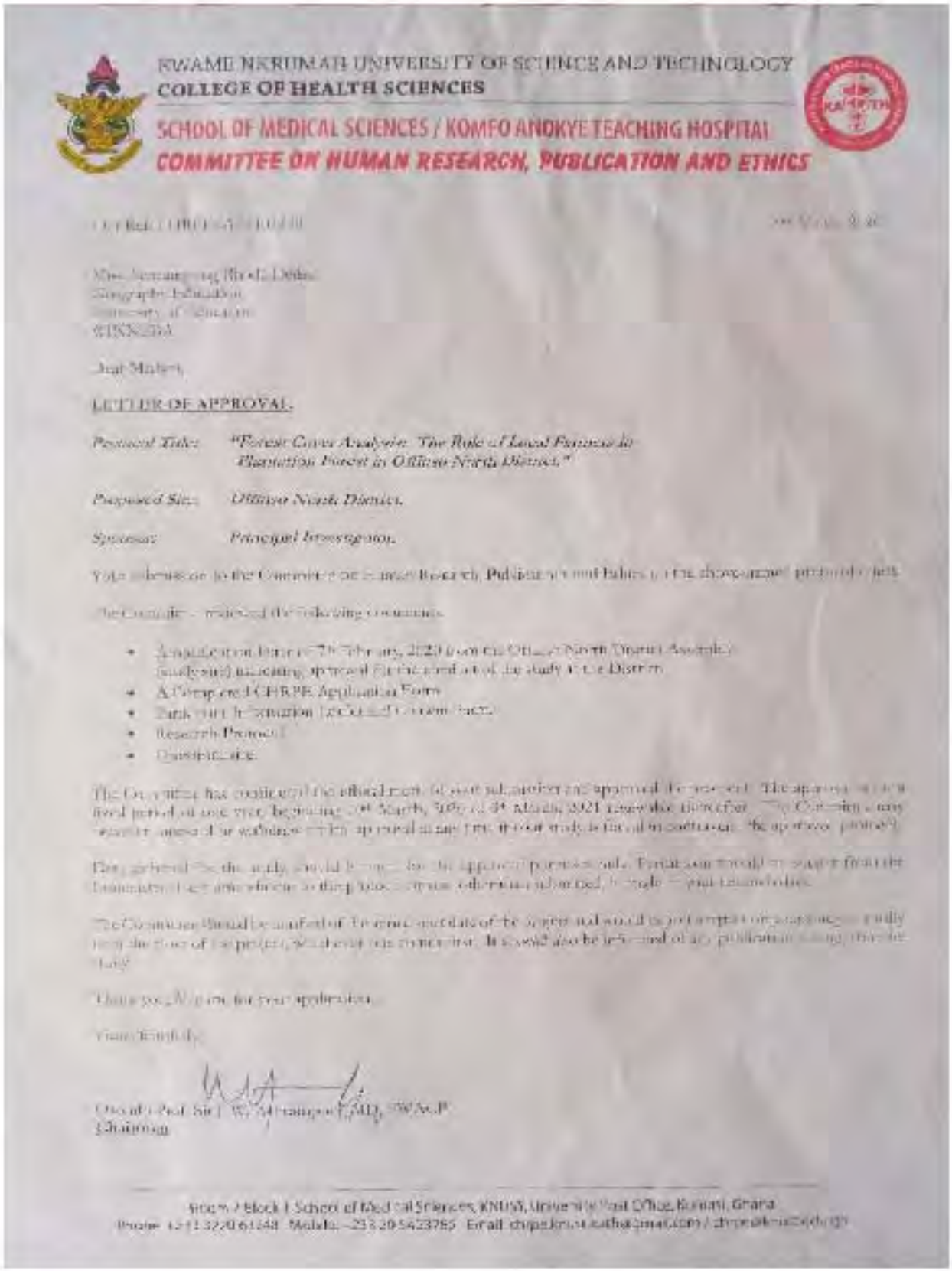
6. Has any attempt been made towards the existing challenge? Yes ( ) No ( )

APPENDIX 11: INTERVIEW GUIDE FOR PADO EXECUTIVES

The aim of this study is to investigate the involvement of members in PADO in forest plantation (afforestation and reforestation) in Offinso North district. All information obtained from this study will remain confidential. Serial numbers instead of names will be used in this study for identification.

1. How did PADO began (initiators/source of it)?
2. How widespread has PADO been in Offinso North District?
3. What intrigue farmers to participate in tree planting in the study area?
4. How has tree planting contributed to the extent of forest cover in the District over three decades?
5. What benefits do member of PADO obtain from tree planting?
6. How important is tree planting to the environment?
7. What are the incentives members of PADO obtain from government and or organization?
8. What are the challenges members of PADO faces?
9. What has been done to these challenges?

APPENDIX 111: ETHICAL CLEARANCE FORM AND CONSENT FORM



KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF MEDICAL SCIENCES / KOMFO ANOKYE TEACHING HOSPITAL
COMMITTEE ON HUMAN RESEARCH, PUBLICATION AND ETHICS

Dear Madam,

LETTER OF APPROVAL

Protocol Title: *"Forest Cover Analysis: The Role of Local Farmers in Plantation Forest in Offinso North District."*

Proposed Site: *Offinso North District.*

Sponsor: *Principal Investigator.*

- A Completed CHRPE Application Form
- Research Protocol
- Questionnaire

Yours faithfully,

Chairman

Room 7 Block I School of Medical Sciences, KNUST, University Post Office, Kumasi, Ghana
Phone: +233 322061648 Mobile: +233 205423785 Email: chrpe@knust.edu.gh / chrpe.knust@gmail.com

CONSENT FORM

Statement of person obtaining informed consent:

I have fully explained this research to _____ and have given sufficient information about the study, including that on procedures, risks and benefits, to enable the prospective participant make an informed decision to or not to participate.

DATE: _____ NAME: _____

Statement of person giving consent:

I have read the information on this study/research or have had it translated into a language I understand. I have also talked it over with the interviewer to my satisfaction.

I understand that my participation is voluntary (not compulsory).

I know enough about the purpose, methods, risks and benefits of the research study to decide that I want to take part in it.

I understand that I may freely stop being part of this study at any time without having to explain myself.

I have received a copy of this information leaflet and consent form to keep for myself.

NAME:_____
___

DATE: _____ SIGNATURE/THUMB PRINT: _____

Statement of person witnessing consent (Process for Non-Literate Participants):

I _____ (Name of Witness) certify that information given to

_____ (Name of Participant), in the local language, is a true reflection of what l have read from the study Participant Information Leaflet, attached.

WITNESS' SIGNATURE (maintain if participant is non-literate): _____

MOTHER'S SIGNATURE (maintain if participant is under 18 years): _____

MOTHER'S NAME: _____

FATHER'S SIGNATURE (maintain if participant is under 18 years): _____

FATHER'S NAME: _____