UNIVERSITY FOR DEVELOPMENT STUDIES

FACULTY OF NATURAL RESOURCES AND ENVIRONMENT

DEPARTMENT OF ENVIRONMENT AND SUSTAINABILITY SCIENCES

EFFECTS OF COMMERCIAL FARMING ON THE INHABITANTS AND WOODY SPECIES OF THE MION DISTRICT

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STUDENT ID: (UDS/MES/0005/19)

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A DISSERTATION SUBMITTED TO THE DEPARTMENT OF ENVIRONMENT AND SUSTAINABILITY SCIENCES,

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NOVEMBER, 2022

DECLARATION

I, hereby declare, that this thesis submitted to the Department Of Environment And Sustainability Sciences. Apart from the citations of other studies which have been duly acknowledged, the result of this study is my own research as a result of effective supervision and that this dissertation has never been presented anywhere for a degree.

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ABSTRACT

Agricultural modernisation is a crucial component and the surest pathway to global food security. In Ghana, agriculture contributes around 20 percent to the country's gross domestic product (GDP) and employs 42 percent of the working population. Commercial farming is a panacea to achieving the Sustainable Development Goals; SDG 1 and SDG 2. However, commercial farming have negative social and environmental consequences which can undermine the local and regional achievement of the sustainable development goals; SDG 13 and 15.The transformation of Savannah woodlands to agricultural lands especially in the Mion district necessitated the need for this study. This study examined the effects of commercial farming on woody species diversity and livelihood of the inhabitants of the Mion District.

The study employed the use of both structured questionnaire, Remote Sensing and GIS methods, as well as vegetation survey techniques The result indicate that commercial farming may have contributed to the limited available land space for small-scale farming. However, further results indicate that commercial farming had offered employment and community support in areas it occurs. The farmland trajectory indicate that a lot of close woodland areas (14.9 %) have been transformed to farmlands. The result further indicated that farmlands now cover nearly half of the district landmass (44.9%), a double of what was present (21.5%) in 2015, leading to an estimated loss of 19117837 individual trees, shrubs and saplings of woody species in the 12,084.6 ha of commercial farms surveyed.

The study concludes that despite the contribution of commercial farming to attaining food security and reducing unemployment, it also causes deforestation and reduction of available fertile land for small-scale farmers. Therefore, stakeholders are entreated to formulate policies to help moderate the amount of farming land leased out to large-scale farmers and that available for the small-scale

farmers to avoid future friction between land users and further develop measures to ensure sustainable agriculture whiles safeguarding woody species.

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Alhamdullilah!

DEDICATION

I dedicate this thesis to my Late father Alhaji Shani Ziblim and Alhaji Abu Iddris who adopted and took care of me from infancy to maturity. I also dedicate this work to my lovely wife Ziblim Kubura and My Mothers Mama Abiba and Hajia Rabi for their support. Without them, I would not have come this far, I say thank you.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Agricultural modernisation has developed into a crucial component and the surest pathway to industrialisation and economic transformation globally (Kondo, 2018; ACET, 2017; AGRA, 2016). The shift of agricultural production from smallholder agriculture (subsistence), low productivity, and food self-sufficiency to market-orientation (commercial farming; high productivity) is important in development and agricultural economics in recent times (Kondo, 2018; Kem, 2017; Hu & Rahman, 2015).

Commercial farming is a remedy to achieving the fundamental Sustainable Development Goals; SDG 1: no poverty and SDG 2: zero hunger. Commercial farming can help end Sustainable Development Goal one on the farmer level when farmers obtain better returns from the sales of their farm produce. That can motivate them to continue and do well in farming (Satyasai & Balanarayana 2018). Moreso, the success of sustainable development goal two (SDG 2) rests upon introducing more sustainable agriculture to ensure food security in harmony with the natural environment (Galeana-Pizaña et al., 2021; Satyasai & Balanarayana 2018).

Food security is a focal point of the worldwide agenda to manage the surge in food demand towards 2030 (Galeana-Pizaña et al., 2021; U.N., 2015). Food security is the availability and accessibility of food by every person and at all times in sufficient quantity and nutritional value to ensure a healthy and active life (Galeana-Pizaña et al., 2021; Clay, 2002).

Domestic food demand is increasing rapidly due to; the growing population, urbanisation, and continued economic growth (Marafa et al., 2020). The provision of food security viz; increasing the local and global food availability and accessibility in their right nutrition (Marafa et al., 2020). The setbacks to the progress in crop production and global food security have crucial implications on sustainable development, including; growth, poverty alleviation, food security, and industrial development for the African continent (Marafa et al., 2020).

In Ghana, agriculture contributes around 20 per cent to the gross domestic product (GDP) of the country and employs 42 percent of the working population (GSS 2016). Over the past thirty years, Ghana's agricultural sector experienced about 5 percent growth per annum, classifying it as one of the top sectors in Africa and help to alleviate poverty and improved food security (Sarpong and Anyidoho 2012; Wiggins and Leturque 2011). Commercial farming contribute to food security and provide a basis for agro-industrial activities and exports. It provides jobs and helps improve the livelihoods of a portion of the population, especially in the rural areas (Teye et al., 2015). The government motivated commercial farmers in Ghana by launching the “planting for food and jobs program on April 19, 2017. This program aims to target interventions that will enhance the transformative aim of expanding the market structure of the small-scale farming sector by providing marketing and input support such as; fast growing and high-yielding crop varieties and improved transportation infrastructure in crop farming areas for farmers (MOFA, 2020).

According to the 2020 composite budget report on Mion district, the primary economic activity in the district is agriculture, with commercial farming employing approximately 65% of the district's male and female labour force.

However, commercial farming has several adverse effects, mainly social and environmental consequences. Some of the social implications of commercial farming are as follows: Where property rights are unclear, land grabbing can occur; commercialisation may lead to a decline in crop diversity for households since it is skewed towards the cultivation of certain crops. The major environmental effect of commercial farming is the deforestation of woody species ecosystems to pave the way for the growth and survival of the elite crops.

Commercial agricultural intensification has dramatically decreased the abundance of woody species on cultivated fields (Bessah et al. 2019). Trees and shrubs which could have provided protection, provision and regulation function in the ecosystem are cleared to give way to commercial farming.

1.2 Problem Statement

Although commercial agriculture is an essential tool to help attain sustainable development goals one and two, its operation can harm woody species' ecosystem function (Migliavacca et al., 2021). Woody vegetation is a major source and sinks for material and energy flow processes of the biosphere and impacts biodiversity. Vegetation changes are often the result of anthropogenic pressure and natural factors (Agyei, 2008; Janetos and Justice, 2000). Woody ecosystems are cleared for commercial farming to ensure food security (Agyei, 2008) due to increasing population growth rates (Galeana-Pizaña et al., 2021).

According to Ayivor & Gordon (2012), over 60% of Ghanaians depend directly or indirectly on agricultural for their livelihoods. This dependency, coupled with timber logging, mining in forested lands, etc., causes deforestation in Ghana. Deforestation by itself can negatively impact climate change through the loss of carbon stocks (Ayivor & Gordon, 2012; IPCC, 2007). Considering the diminishing forest resources due to the country's population growth, Ghana is likely to become one of the net importers of wood in the 21st century (Kusimi 2008) if immediate measures are not put in place to reforest degraded lands. The issue of deforestation in Ghana can undermine the local and regional achievement of the sustainable development goals thirteen and fifteen (SDG 13 & 15): which focus mainly on climate change and life on land (i.e., plants and animals), respectively.

A study conducted by Bessah et al. (2019) revealed that the encroachment of agriculture and pasture lands into forest landscape were the key land cover transformation. Similar finding was confirmed by Bruinsma (2003) on the transformation of Savannah forest, which he ascribed to the encroachment of agricultural lands and plantation establishment.

Mion district is not exempted from the current land use and land cover transformations to commercial farming as the 2021 best farmer in Ghana, has large hectares of commercial farms in the district. Based on the above, the following research questions have been formulated to find concrete answers to them:

1. What is the effect of commercial farming on the livelihood of the inhabitants of the Mion district?
2. What is the effect commercial farming on the land cover of Mion district?
3. What is the effect of commercial farming on woody species types and number in the Mion district?

1.3 Justification

The contribution of commercial farming in attaining SDGs 1 (No Poverty) and 2 (Zero Hunger) cannot be overlooked. Especially in Ghana, where agriculture is the primary economic activity employing 42 percent of the economically active population and contributing about 20 percent to the gross domestic product of the country (GSS 2016). This supports the introduction of the planting for food and jobs program to ginger farmers by expanding the market structure of the small-scale farming sector and providing market support and farming inputs, i.e., high yielding crop varieties and better transportation network in crop growing areas among others for farmers (MOFA, 2020).

Nevertheless, commercial farming threatens the woody vegetation cover, especially in the Mion District of Ghana, which now serves as a hub for commercial farm operations. , Deforestation in the Mion district can undermine the local and regional achievement of the sustainable development goals thirteen and fifteen (SDG 13 & 15): which focus mainly on climate change and life on land (i.e. plants and animals) correspondingly.

These effects of commercial farming have triggered numerous researchers to ascertain the extent of damage caused by commercial farming on Ghana's vegetation cover. However, most of the studies have focus solely on; Assessment of Agricultural Commercialisation in Ghana (Teye & Torvikey, 2018; ACET, 2017) and Forest (Savannah) Fragmentation assessment (Adade et al., 2017; Bessah et al., 2019; Kondo, 2018; Teye et al., 2015; Yeboah et al., 2017). There seems to be little or no information (literature) on the effect of commercial farming on the inhabitants and the woody species diversity in the Mion District of the Northern Region of Ghana.

It is against this backdrop that motivated this current study. Findings from this study will contribute information to existing literature and help policymakers draw intervention measures to help manage Ghana's commercial farming and the natural environment sustainably.

1.4 General Objective

The general objective of this study was to assess the extent to which commercial farming affects woody species diversity and livelihood of the inhabitants of the Mion District of the Northern Region.

1.4.1 Specific Objectives

The specific objectives of this study were to:

1. Assess the effect of commercial farming on the livelihood of the inhabitants of the Mion district.
2. Assess the land cover change of Mion district due to commercial farming.
3. Quantify woody species loss as a result of commercial farming in the Mion district.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Concept of Commercial Farming

Commercial farming is the agricultural (crops and animals) transformation process in which farmers move from highly subsistence farming towards more specialized production, intended for markets input procurement and output supply (Herens et al., 2018; Jaleta et al., 2009). In commercial farming, the area cultivated and the capital used are huge, with most work being done by machines. Commercial farming aims to attain the Sustainable Development Goal of zero hunger (USAID, 2016), with much reverence given to the role of available food (with the right nutrition) in eradicating hunger for all by 2030.

Global food systems are experiencing a swift transformation, in which current supply chains are coping with the economic, environmental, market, and dietary changes (Herens et al., 2018). There is an ongoing change in preference from local food systems is attributed to small-scale production by a large group of smallholders to the growth of commercial farming and more complex global supply chains (Westhoek et al., 2016; Carletto et al., 2015). Due to this assertion, small-scale farmers are progressively adopting commercialization with significant improvements in agricultural outputs (Westhoek et al., 2016; Carletto et al., 2015), to help ensure local and global food security.

2.2 Africa Commercial Farming

Agriculture is considered a significant factor in the growth and development of Africa and the nourishment of its rural, peri-urban and urban citizens. Although the contribution of agriculture to the gross domestic product (GPD) differs widely from one country to the other, agriculture averagely contributes nearly 17% of value-added to the GDP of the African continent (World Bank, 2016).

In recent decades, agriculture has constituted about 40% of Africa's exports and employs over 55% of the labour force (Marafa et al., 2020; African Development Bank (AfDB), 2014). An approximated population of 227 million Africans are extrapolated to draw livelihoods from agriculture (Marafa et al., 2020; AfDB 2014).

Africa's agriculture plays a major role in providing food and nutrition security, employment, poverty alleviation, and the overall economic development in the continent (Marafa et al., 2020; African Union (A.U.), 2011). Meanwhile, Africa is now one of the net importers of agricultural produce (May, 2018; Rakotoarisoa et al. 2011; AU, 2011; Li et al. 2009). The continent has the lowest yield of any global region, due to vast acreages of unutilised arable land (Marafa et al., 2020). Africa owns 25% of the cultivable land globally, nevertheless, it contributes just 10% of the global agricultural produce (Jayaram et al., 2010). Moreover, land under cultivation in Africa is dawdling in the application of technology, and improved farming methods, with only 10% of the croplands prepared by machines and 4% of the cultivated croplands under irrigation (Marafa et al., 2020).

The Food and Agriculture Organization (FAO), documented that, only 14% of Africa's total 184 million hectares of cultivatable land is being used for production, with 93% of that relying solely on rainfall and minimum fertiliser application (Alden, 2013). An estimate done by the World Bank shows that 60% of the world's unfarmed land is in Africa (Marafa et al., 2020). Again, the African Development Bank disclosed that of the 400 million acres that can effectively support agriculture in Africa, less than 10% are currently under cultivation, while over half of the world's fertile yet unutilised croplands are found in Africa (Marafa et al., 2020; AfDB 2014).

The problems associated with Africa's agriculture ranges from widespread cropland and forest cover degradation to lack of skills, machinery, and negligence by the political leadership.

2.3 Ghana Commercial Farming and its Contribution to the Economy

The major economic activity in Ghana is agriculture as it contributes about 2 percent to the country's GDP and employs 42 percent of the economically active population (GSS 2016). Ghana's agricultural sector comprises four broad sub-sectors, namely crops, animals, fisheries, and forestry. The crop sub-sector is key to increasing the employment rate in the country and contributing to the nation's GDP and wealth creation (Teye & Torvikey, 2018). Being the most prominent economic activity in Ghana contributing to 13.8 percent of GDP, it added 0.7 percent growth to the 2019 annual gross domestic product (Essegbey and MacCarthy, 2020).

Although Ghana has a total landmass of 238,535sq km, only 57 percent is arable (Teye & Torvikey, 2018). There are three distinct agro-ecological zones: forest, savannah, and coastal zones. Crops grown in the forest zone include cocoa, oil palm, coffee, rubber, cashew nut, citrus, plantain, and cocoyam. The savannah zones support shea, yam, maize, sorghum, millet, cowpeas, and groundnuts. Vegetables, maize, sugar cane, sweet potato, soya bean, cassava, and coconut are mainly grown in the coastal areas. Rice, cassava, mangoes, and vegetables are widely cultivated across the three agro-ecological zones (Teye & Torvikey, 2018).

Ghana's agricultural sector developed at about five (5) percent per annum averagely over the past three decades, making it one of the top performers in Africa and ensuring poverty reduction and food security (Sarpong and Anyidoho 2012; Wiggins and Leturque 2011). However, the growth in the agricultural sector reduced by 4.6 percent in 2019 compared to the 4.8 percent growth rate in 2018, with a GDP decline from 19.7 percent in 2018 to 18.5 percent in 2019 (Essegbey and MacCarthy, 2020). Commercial farming among other things contributes to food and nutrition security and also helps in the supply of agro-industrial activities and exports inputs. Commercial farming provides jobs and improves the livelihoods of a significant proportion of the country's population, especially in rural areas.

The agricultural sector is highly threatened by a number of factors such as; climate variability as crop production in Ghana is mainly rain-fed (Teye et al. 2015); land tenure insecurity (Amanor 2010); low productivity resulting from the limited use of technology (Sarpong and Anyidoho 2012) and lack of infrastructure (e.g. roads to convey farm produce to market) (Martey et al. (2012). According to Ghana Statistical Service 2016 report, the agricultural sector contributes significantly to food security and poverty alleviation. Despite the agricultural sector's contribution to food security, a significant percentage of the country's population, especially in the drier zones, are food insecure because they depend on rain-fed subsistence agriculture (Teye & Torvikey, 2018).

2.4 Effects of Commercial Farming on Ghana's Vegetation Cover

The negative effect of commercial farming on the vegetation cover through deforestation and forest degradation is portrayed by the large hectares of cultivated farmland. Currently, commercial farming covers about 20 million hectares of the landmass of Ghana (MoFA, 2020; Essegbey and MacCarthy, 2020). The recent agricultural flagship programme i.e., Planting for Food and Jobs (PFJ) will contribute massively to the degradation of Ghana's woody-vegetation cover because farmers are motivated to clear more trees and shrubs to pave the way for their elite crops. Over 60% of Ghanaians depend directly or indirectly on agricultural land for improved livelihoods (Ayivor & Gordon 2012). As a result, woody ecosystems are cleared for commercial farming to ensure food security (Agyei, 2008) due to increasing population growth (Galeana-Pizaña et al., 2021).

2.4.1 Land Use Land Cover Change

According to Lambin et al., (2006) and Astuti, (2017), land use and land cover are often used interchangeably, however, there are significant differences between these terms. Land Use/Land Cover represents a broad aspect signifying the relationship between natural and anthropogenic impact on the earth's surface (Astuti, 2017). The land cover represents biophysical features of the earth's surface, such as; vegetation, soil, water bodies, and built-up areas. In contrast, land use is the objective for which land cover has been modified (Lambin et al. 2006). According to Yeboah et al., (2017) and Schulze, (2000), land cover can also be defined as the observed biophysical state of the earth's surface, while land use is the utilisation of the various land cover by humans at different management levels, driven by production and consumption dynamics that are closely tied to social, political and economic activities, leading to land cover modification to satisfy human needs. Therefore, land use/land cover change has a unique signature on the landscape and soil distribution that gives rise to a shift in natural resources (Hu et al., 2005).

The extent of land use and land cover changes are increasing rapidly globally, and this will significantly affect critical aspects of earth system functioning due to their direct impact on worldwide biodiversity as well as contribute to local, regional and global climate change (Lambin et al., 2001; Sala et al., 2000).

Land cover change can modify the biodiversity, main and potential primary productivity, soil fertility, runoff quality, sediment haulage, and a host of other processes that are found in the terrestrial ecosystem (Steffens et al., 2004). Land cover change can be grouped into land cover conversion and land cover modification. The replacement of one type of land cover with another is termed, land cover conversion while land cover modification represents changes to its characteristics without a total change in the land cover itself (Verburg et al., 2006).

2.4.2 Causes of Land Cover Change

Land cover changes are caused by several factors that are termed, drivers. The drivers of land cover change are regarded as an activity that influences a change in the natural state of land cover (Astuti, 2017). The drivers of these changes have been grouped into direct and indirect causes (Lambin et al., 2001). The direct causes, also termed as proximate causes, are considered to be anthropogenic activities such as agriculture or settlement expansion, logging, mining, population increase, and economic development that directly transform or alter the land cover (Iqbal, 2012 & Ouedraogo et al., 2010).

These underlying drivers of land cover change do not occur in isolation but exhibit a complex link among different indirect factors (Mather, 2006), which include; social, political, economic, demographic, technological, cultural, institutional, and biophysical factors (Li et al., 2006; Lambin et al., 2001). Land use change may take place steadily or even more quickly due to specific occurrences such as natural hazards or changes in political forces (Kariyeva and van Leeuwen, 2012).

2.4.3 Changes in Agricultural Land Cover

Agricultural lands have expanded in all the regions of Ghana, but the most significant conversions were observed in the north-eastern, east-central, and south-western parts of Ghana (CILSS, 2016). The rise in acreages of agricultural land cover suggests the conversion of other land cover types, such as forests, woodlands and savannahs to fragmented vegetation cover (CILSS, 2016; Appiah et al., 2014). Also, some agricultural lands have been changed to urbanisation, particularly in the peri-urban areas, thus, areas that combine urban and rural areas activities (Kasanga et al. (2018). The frequent agricultural expansion can be attributed to the acceleration of improved and quality agricultural extension services, availability of farming inputs i.e. mineral fertilisers, pesticides, improvement in seed varieties and subsidized inputs prices introduced by the government. However, the surge in agricultural production is mostly taking place in the Northern part of the country as well as the Western and Ahafo Regions, which have experienced growth in croplands over the years (Kleemann et al., 2017).

This is possible because urbanisation is comparably less severe in some regions, particularly those located in the northern parts of Ghana (Kleemann et al., 2017).

2.4.4 Changes in Grassland Cover

Grassland ecosystems are composed of Guinea, Sudan, and Coastal Savannah and occupy about two-thirds of the total landmass of Ghana (GSS, 2013), and are also considered the second most paramount wildlife habitat in Ghana following the high forest zone. The degradation or loss of grassland is therefore very crucial. On the contrary, they are being degraded by numerous anthropogenic activities such as; excavation of woodlands for agriculture employing slash and burn land clearing practices, settlements expansion, fuelwood gathering, indiscriminate bush burning, and overgrazing (Koranteng et al., 2017).

The loss in grassland land cover is an indication of its conversions to other land cover type, the degradation of the savannah biodiversity is likely exacerbated due to the fact that they accommodate approximately 20% of the country's population and produces fuelwood in bulk for supply in Ghana at large and the production of cereal grains (Braimoh, 2004).The loss in grasslands cover across Ghana is evidence of high exploitation to satisfy human needs, resulting in the conversion to other land cover type, such as cropland, other vegetation, bare land, or built-up structures. Mining activities are also known to be one of the major causes of the degradation of the grassland ecosystem (Awumbila and Tsikata, 2007).

The immigration of people to mining centres cause an inflow of people into the mining communities, resulting in the enlargement in settlement areas and a decline in vegetation cover (Basommi et al., 2015).

According to Basommi et al., (2016); Kugbe et al., (2012), wildfires are also a major cause of the dwindling savannah vegetation cover. The aftermath of bush fires, large-scale farming, and fuelwood collections are the cause of the vulnerability of savannah vegetation in the northern part of Ghana. This could result in local climate change and variability in addition to extreme climate events such as erratic rainfall patterns, dry spells, and high temperatures (Incoom et al., 2020; Leemhuis et al., 2009). Amoako et al. (2018) disclosed that fire is a ubiquitous tool used to burn bush with the goal of stimulating early germination and development of fresh forage for livestock, land clearing, wild honey harvesting, and game hunting have negative implications on Savannah vegetation cover. They also established that burning harmed tree density when they studied the effects of annual wildfires on tree species in the Guinea Savannah woodland.

2.5 Digital Image Change Detection

Satellite Remote Sensing and Geographic Information System are the most recognized methods for quantification, mapping, and detection of patterns of land use and land cover changes (LULCC) because of their accurate georeferencing approach (Rahman et al. 2011; Nuñez et al. 2008).

A digital format is suitable for computer processing and repetitive data acquisition (Hassan et al., 2016; Rahman et al. 2011; Nuñez et al. 2008). The digital change detection approach has been used widely to ascertain and describe the increasing changes in land use and land cover (LULC) trends based on multi-temporal remotely sensed data.

The primary goal of using this data to detect changes in land cover is to identify uncharacteristic changes between two or more dates (Hassan et al., 2016). Several procedures have been developed and applied in LULCC change detection to assess the dynamics in LULC types by utilising remotely sensed data for image differencing, post-classification change detection, vegetation index differencing, and principal components analysis (Lu et al. 2004). Among these change analysis techniques, post-classification change detection was reported to be the most accurate procedure by several studies as it provides an advantage of representing the nature of occurring changes as it compares classifications of multi-dates images, which are independently built to detect land cover changes (Hassan et al., 2016; Yuan et al. 1999).Thus, using the post-classification comparison method minimises associated problems with multi-temporal images recorded under different atmospheric and environmental conditions. In using remotely-sensed information and GIS to detect LULC changes, six main steps are essential, as mentioned by Jensen (2005). Below is a figure that depicts the chronological steps of digital image change detection.

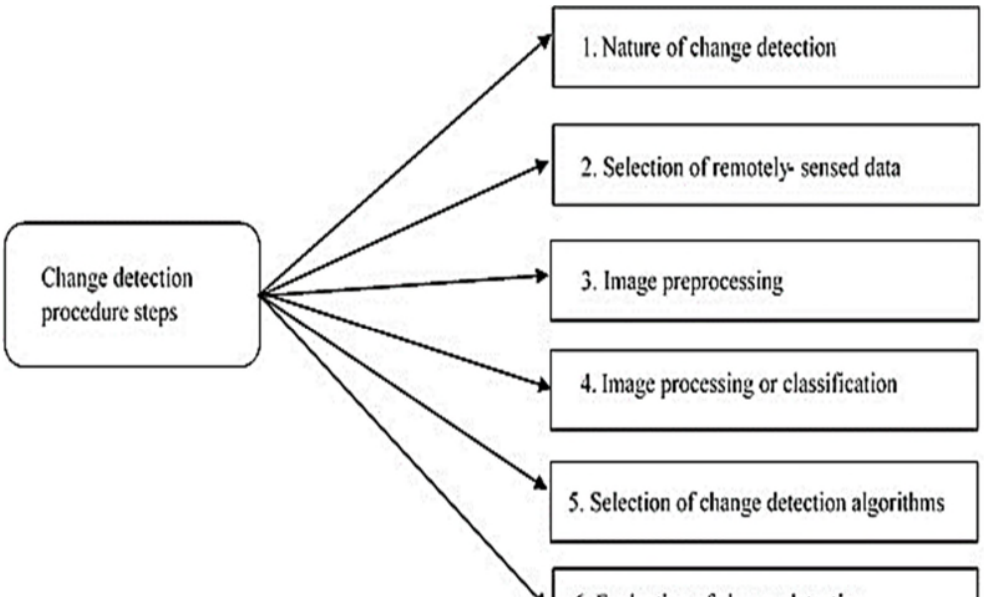

Figure 1: LULC change detection procedure (Jensen, 2005)

2.5.1 Digital Image Preprocessing

Satellite image pre-processing is the preparatory phase designed to improve the quality of the image features before image analysis and interpretation (Munthali, 2020). Digital image pre-processing operations are carried out to correct distorted or degraded image data to create a more authentic representation of the original scene and improve the image's utility for further manipulation (Lillesand et al., 2014).

According to Chuvieco & Huete (2010), digital imagery contain some errors in both the radiance captured and the position of resulting pixels. These errors occur due to atmospheric effects, terrain variations, earth’s curvature and rotation, variations in orbit altitude and sensor’s miscalibration (Chuvieco & Huete, 2010; Jensen, 2005). These errors must be corrected through radiometric and geometric corrections.

Pre-processing involves the initial processing of raw image data to eliminate noise present in the data, calibrate the data radiometrically, correct for geometric distortions, and expand or contract the extent of an image via mosaicking or subsetting (Lillesand et al., 2014). Satellite image pre-processing is crucial in any digital change detection as any misregistration will produce false results (Adusei, 2014).

2.5.2 Digital Image Classification

Image Classification is the process of sorting pixels into a finite number of individual classes or categories of data based on the spectral response pattern present in the image data (Lillesand and Kiefer, 2008). There are mainly two image classification methods: supervised and unsupervised classification. These are often called hard classification, sub-pixel classification, and fuzzy classification is also termed soft classification methods (Hassan, 2010; Key et al., 2002; Foody and Atkinson, 2002).

Supervised classification is closely controlled by the analyst. In this method, the analyst sort pixels representing a particular pattern or land cover type in the satellite image to train the computer system to categorise the pixels with similar spectral features. Unsupervised classification is more of a computer-automated classification process. Still, the analyst will have to specify some parameters that the computer uses to sort spectral patterns inherent in the image data. Image Classification algorithms may be grouped into two types: parametric or nonparametric.

Parametric algorithms assume a class statistical distribution, i.e., the mean or covariance matrix of pixels in the training cluster. Nonparametric algorithms make no assumptions about the probability distribution and are often considered robust (Hassan, 2010).

2.5.3 Accuracy Assessment

Accuracy assessment is an important stage in the satellite image classification (Rwanga and Ndambuki, 2017) and possibly the most crucial part in ascertaining LULC and LULCC detection to appreciate and estimate the changes accurately (Firdaus, 2014). Accuracy assessment compares classified image data with ground data to evaluate how well the classification represents the real world. Accuracy assessment plays a crucial role in satellite image classification (Congalton and Green, 1999). The error matrix, also known as the confusion matrix, has become a standard in evaluating the accuracy of classified images (Congalton, 2004).

The error matrix compares the relationship between classified thematic and the reference data from ground control points collected to generates report on the overall accuracy, producer accuracy, user accuracy and kappa coefficient (Congalton, 2004). Image classification is incomplete until its accuracy has been assessed. The overall accuracy of the classified satellite image indicates how each pixel is classified against the land cover types in reality obtained from their respective ground control points (Adade et al., 2017). Producer accuracy measures errors of omission, which measures how well real-world land cover types can be classified by expressing how often actual features, in reality, are correctly identified on a classified thematic map (Adade et al., 2017).

In contrast, user accuracy measures errors of commission and report the likelihood of a classified pixel matching the land cover type in reality (Ye et al., 2018). The kappa coefficient has become a standard means of image classification accuracy assessment as it has been used in numerous land classification studies (Rwanga and Ndambuki, 2017). Kappa coefficient value between 0.8 and 1 means there is perfect agreement; the value range between 0.4 and 0.80 means there is moderate classification, and values from 0.4 to 0 means the agreement is not better than expected by chance (Firdaus,2014; Jansen and Di Gregorio,2004).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The Mion district (fig. 2) was carved out of the Yendi Municipal Assembly based on the growing population in the area and to ensure that development reaches all communities in the area. The capital of Mion District is Sang (Ministry of Finance and Economic Planning, 2020). The district has three (3) area councils: Sang, Jimli, and Kpabia. Mion District is geographically lies between Latitude 90 – 35" North and 00 – 30" West and 00 – 15" East (fig. 2). The district borders Tamale Metropolis, Savelugu Municipal and Nanton District to the west, Yendi Municipal to the east, Nanumba North and East Gonja districts to the south and Gushegu and Karaga districts to the north (USAID, 2016).

The district covers a total land area of 27,141km^2 and has a population of 91,216, out of which 45,895 are females and 45,321 are males (Ministry of Finance and Economic Planning, 2020). People who live in urban communities in the district constitute 8.9%, whiles those living in rural areas stands at 91.9% (Ministry of Finance and Economic Planning, 2020). The total Household population of the district is 81,026, whiles the total male household heads are 8,253 and female household heads are 589 (USAID, 2016).

Most of the population of the district are predominantly peasant farmers depending largely on rain-fed crop farming and animal rearing. Agricultural activities identified in the district are crop farming (98.7%). Tree planting (0.3%) and Livestock farming (54.8%). The rural areas account for 93.1% of the Agricultural household. For crop farming, the farmers are engaged in the production of Cereals such as Maize, Sorghum, Millet, and Legumes such as Groundnuts, Cowpea, Soybeans, and Tubers, including Yams, Cassava and Sweet potatoes. A sizeable number of the population, especially women, also cultivate some vegetables in the rainy and dry seasons along the river Daka. The majority of the people also rear animals, including large and small ruminants. Poultry production is also not left out; a majority of the people, especially women, rear a lot of local poultry, including Guinea fouls and Ducks. The women are also engaged in agro-processing like shea, dawadawa and cashew processing as well as charcoal burning as their alternative livelihood during the offseason, whiles the Men are also engaged in wood curving and beekeeping. Dry season vegetable production and hunting, among others, are some of the activities undertaken during the lean season.

The vegetation is a typical Guinea Savannah agro-ecological zone of Ghana. The main vegetation is grassland, interspersed with guinea savannah woodland, characterised by drought-resistant trees such as *Acacia spp, Adansonia digitata, Vitellaria paradoxa, Parkia biglobosa, Azadirachta indica,* etc., (Ministry of Finance and Economic Planning, 2020). The district's climate is relatively dry, with a unimodal rainy season that starts from May and ends in October. The rainfall recorded annually varies between 750 mm and 1050 mm (Ministry of Finance and Economic Planning, 2020). The dry season starts from November and ends in March/April, with maximum temperatures occurring at the peak of the dry season and minimum temperatures occurring in December and January. The Harmattan winds, which take place from December to early February, have a significant effect on the temperatures in the district. The temperatures may vary between 14˚C at night and 40˚C during the day. Very low humidity mitigates the effect of daytime heat (Ministry of Finance and Economic Planning, 2020).

3.1.1 The sample population of the study

The study targeted some commercial farmers, some peasant farmers, and Opinion leaders. Executives of Farmer Based Organisations (FBOs), Chiefs and women Shea and Dawadawa pickers in the Mion district. A total of 30 commercial farmers were randomly selected for the study. These commercial farmers were located in Zakpalsi, Sakpe, Warivi, Kayang, Chegu, Tijo, Adam Kura, Puriya, Kpalikore, Daboagni and Sanzei among others.

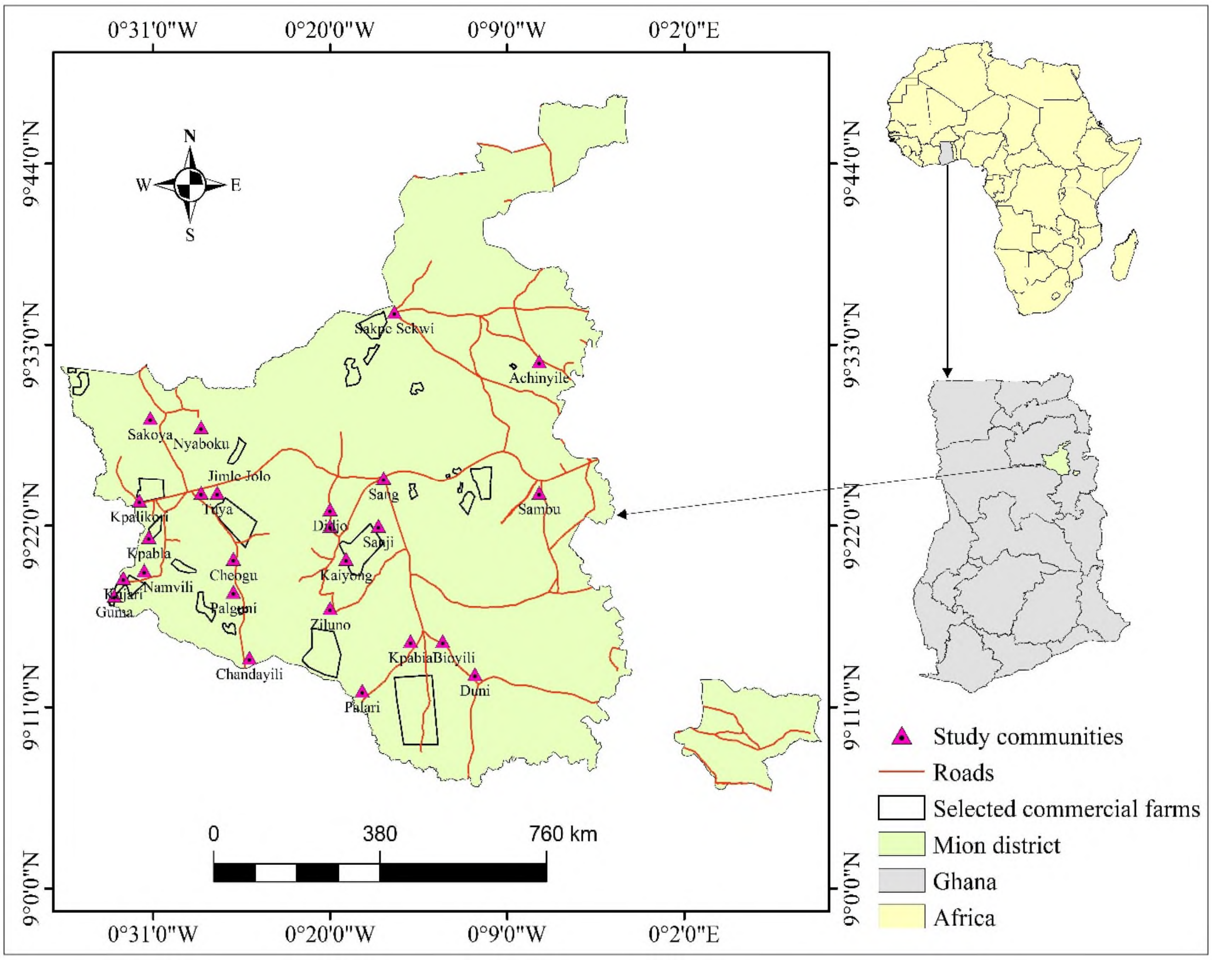

Figure 2: Map that shows the study areas in the Mion district.

3.2 Data Collection

3.2.1 Effects of commercial farming on the livelihood of the inhabitants

This objective employed the use of structured questionnaire (appendix 3) to elicit data on the impact of commercial farming on the livelihood of the inhabitants of Mion district. The questionnaires were administered to people whose farmlands have been affected due to the invasion of commercial farming and persons in close proximity who benefited from those lands either than farming on them (i.e. those who used to gather Non-Timber Forest Products on those lands) to areas where commercial farming is currently taking place.

A total of 200 people took part in this study. Additionally, focus group discussion was also used to interact with opinion leaders in the communities benefiting from commercial farming to gather detailed information on the practices of commercial farming and the implications on them in the near future going forward.

3.2.2 Vegetation Cover Change Assessment

3.2.2.1 Satellite Image and Ground-truth Data Collection

Cloud free Sentinel-2 satellite image of Mion district was acquired for 2015 and 2021, that is, before and during the advent of commercial farming in the district, from http://earthexplorer.usgs.gov for analysis using Erdas Imagine (2015 version).

A cloud-free satellite image is devoid of clouds that prevent constant observation using optical sensors from space (Hansen and Loveland, 2012). Ground truth data was obtained for validation and accuracy assessment with a Garmin GPSmap 62 receiver. Ground truth data is necessary to relate remotely sensed data to the ground (Ducgin, 1987). A total of 500 GPS coordinates were collected in the Mion district to aid in classification and post-classification accuracy assessment.

3.2.2.2 Satellite Image Pre-processing

The downloaded satellite images were extracted into various bands in a Joint Photographic Experts Group 2000 format (JPEG 2000). A composite image (img file) was formed by merging the various bands (JPEG 2000) in Erdas Imagine 2015 software.

The composite images were pre-processed before digital image classification to correct errors due to atmospheric and radiometry effects. Histogram equalisation under radiometric correction in Erdas Imagine 2015 was used to correct varying sun angles and surface reflectance changes (Markham & Masek, 2018; Demirel et al., 2009).

The individual images were further filtered using "standard filters" to enhance their sharpness in Erdas Imagine 2015 software. The satellite images were already projected to Universal Traverse Mercator Coordinate System Zone 30N WGS 1984, so there was no need for further geometric correction since Ghana falls under this World Geodetic System (LUPMIS, 2020). Finally, the study area, i.e., Mion district, was clipped from the larger satellite image using the vector dataset (shapefile of the Mion district) for classification and post-classification change detection (Figure 3).

3.2.3 Assessment of woody species diversity and abundance

3.2.3.1 Field layout

The woody biodiversity assessment was focused on the identification and types of woody species within the unfarmed areas as against the commercial farming area. Thirty (30) unfarmed fields (beside the 30 commercial farms that were randomly selected) in the Mion District were considered. A total of sixty (60) plots were laid for the woody species enumeration. Based on which two plots of size 25m×25m were laid following a systematic random sampling in each unfarmed field to assess the woody species diversity and abundance in each unfarmed area. The systematic random sampling was done by, establishing the first plot at a random location. Afterwards, the second plot was randomly located at a regular distance of 50 - 100 meters apart. Woody species within the established plots were identified, first, by their local names (Dagbani) with the help of a herbalist and later cross-checked for their scientific names from Blench, & Dendo (2006).

3.2.4 Mapping of the sampled commercial farms in the Mion district

The sampled commercial farms were mapped by either tracking their boundaries on the field to create a polygon or digitising from Google-earth. Farm sizes ranging from 200 hectares and below were manually tracked on the field whiles, for farm sizes above 200 hectares, GPS points were picked at random points within and around the various farms in this category. The GPS data were later converted to shapefiles of the various farms. The shapefiles (points) for the individual big farms were overlaid in Google-earth, and their respective boundaries were traced as shown in plate 1.

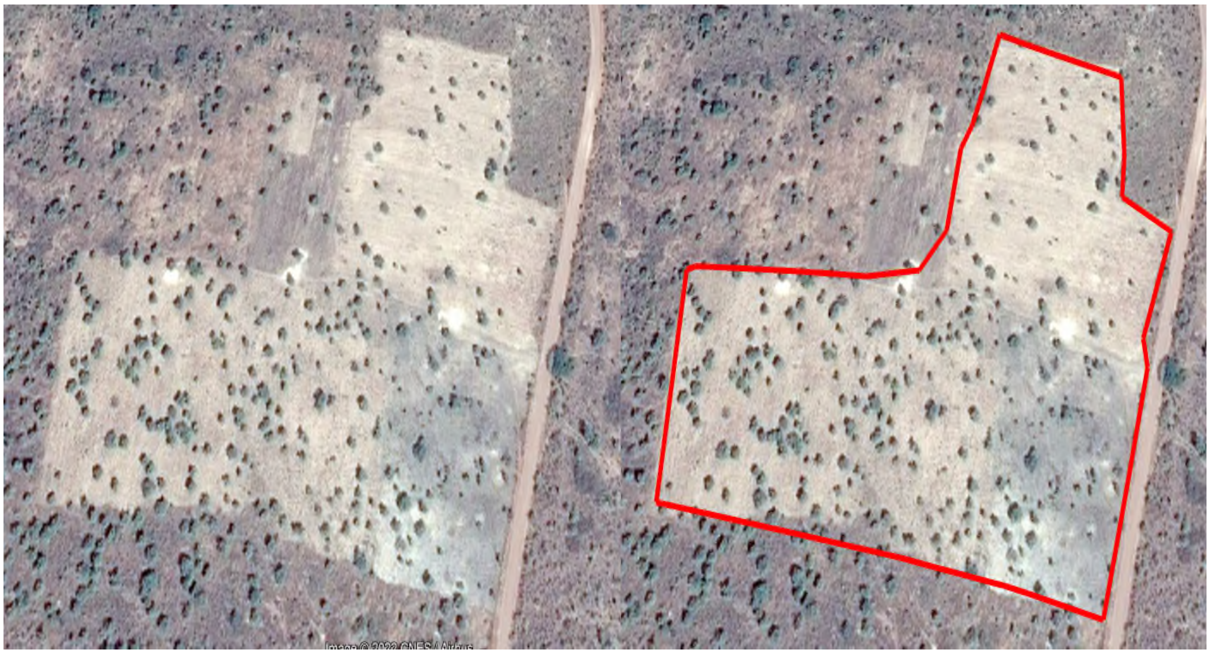

Plate 1: Digitised commercial farmland from Google-earth

3.3 Data Analysis

3.3.1 Effect of commercial farming on the livelihood of the inhabitants

Data collected via questionnaire were organised, coded, and entered in Statistical Package for Social Scientist (SPSS) by way of coding and organising the data set collected for easy analysis and interpretation. The data were then analysed using descriptive statistics in SPSS version 20.

3.3.2 Vegetation Cover Change Assessment

3.3.2.1 Digital Image Classification

Supervised classification using maximum likelihood algorithm was employed in the image classification. The appropriate and best classification method was supervised classification with maximum likelihood algorithm for land use/cover classification (Hussain et al., 2013). This is because, in maximum likelihood classification, each pixel is assigned to the class that has the highest probability (Richards, 1999).In the supervised classification technique, signature files were created based on the spectral reflectance in the sentinel-2 satellite image data and ground truth points to train the algorithm, which then sort and grouped pixels based on their likelihood to belong to a specific land cover class (Figure 3).

Five land use/cover classes were considered these are; closed woodland (these were areas with dense vegetation and sometimes canopies inter-lock), opened woodland (trees in these areas were not very close together; hence, trees canopies were not continuous), farmland (Subsistence and Commercial agricultural lands), water bodies (include; streams, dams, and dugouts) and bare/build-up (exposed land surfaces and settlement areas).

3.3.2.2 Accuracy assessment

The final stage of digital image classification is the accuracy assessment (Manisha, 2012). Accuracy assessment is a tool used to evaluate the classification approach to determine whether there is an error between the classified image data and the corresponding reference data from ground control points (Zahraa and Jaber, 2020). Accuracy assessment was carried out using the confusion matrix to compare the relationship between classified thematic and the reference points from ground-truthing.

A total of 250 points were used to ascertain the accuracy of the classified thematic by considering the following parameters; producer accuracy, user accuracy, overall accuracy and kappa statistics.

3.3.2.3 Post classification change detection

Post classification change detection was applied to assess the trend in land-use/landcover change (LULCC) between 2015 and 2021. The Post-classification technique is the most commonly used quantitative change detection method in satellite data (classified) change detection (Goswami et al., 2022; Ayele et al., 2017).

The matrix union (a change detection matrix) in Erdas Imagine software version 2015 compared the 2021 and 2015 maps pixel by pixel. This technique helps to ascertain which of the classified LULC class in the previous year (2015) has changed to what LULC class in 2022. The output thematic images were then recoded and further produced in ArcGIS 10.8 software.

Finally, after the post-classification change detection assessment, the extent of land use/cover transformation to farmland in Mion district over the six years was estimated by sorting all areas which were or had been converted to farmlands and made to stand out as an individual class, e.g. Closed woodland to farmland, Opened woodland to farmland, etc. Also, all areas that were not farmland or had been converted to farmland were put under one class (i.e. other conversions), in a similar manner employed by Owusu et al., (2018) on LULC change trajectory analysis Bounfum forest reserve in Ghana (Figure 3).

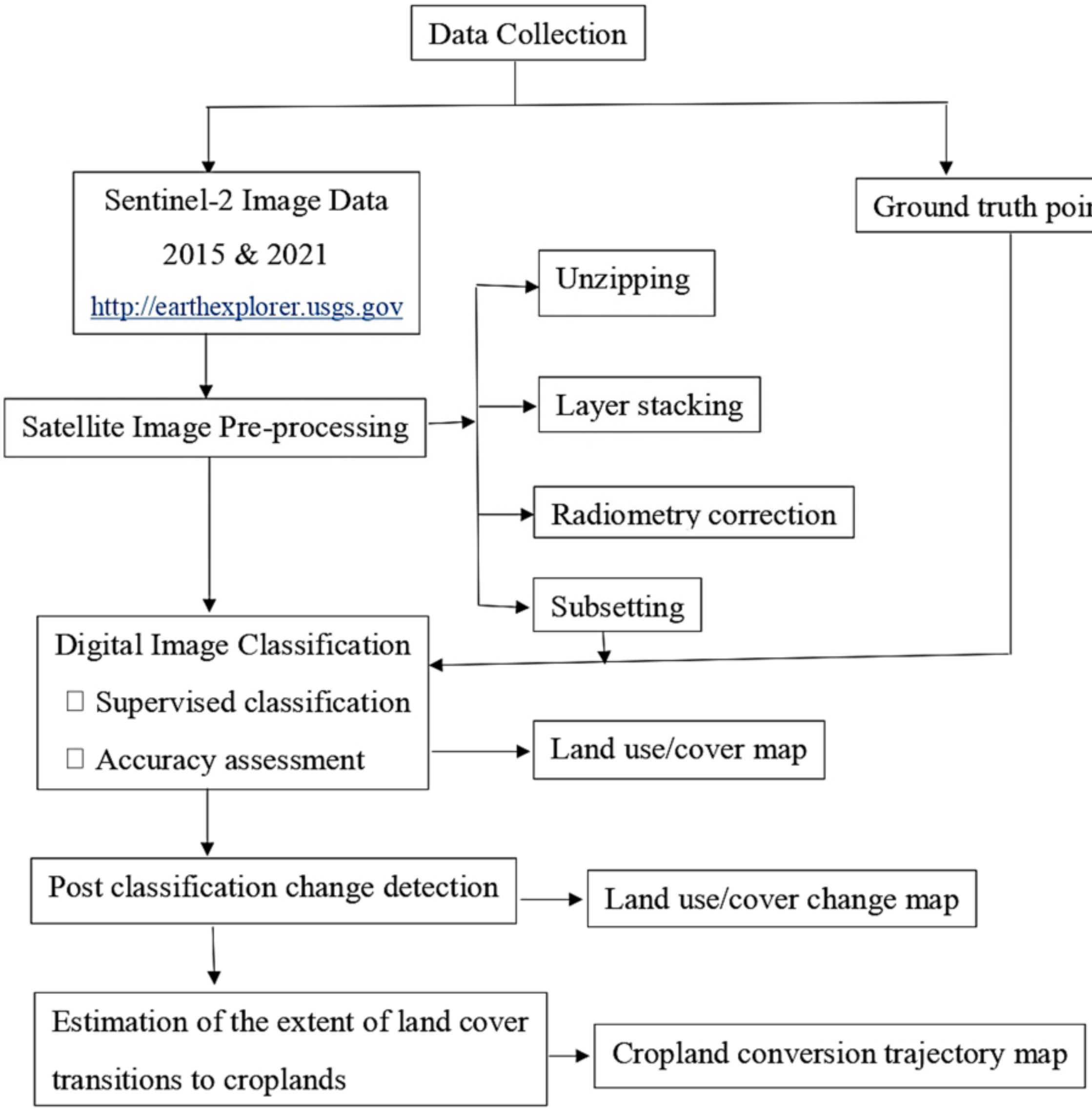

Figure 3: Sequential order for estimating the extent of agricultural transformation

3.3.3 Assessment of woody species diversity and abundance

3.3.3.1 Species Diversity

The diversity of woody species in the Mion district was quantified using the Shannon-Wiener species diversity index. The Shannon index is the most widely and commonly used diversity index in the ecological literature because it accounts for the abundance and evenness of the species present (Sarma & Dhruba, 2015). The Shannon diversity index and Shannon equitability (evenness) were estimated using the formulae below:

$$H = -\sum_{i=1}^{s}(Pi\ lnPi) \quad \text{..........} (1)$$

H = Shannon Wiener's diversity index,

Pi = Relative abundance of the ith species

lnPi = Natural log of the corresponding relative abundance (Pi) of the species

$$EH = H/H\max \quad \text{..........} (2)$$

$E_{.H.}$ = Shannon's equitability

H = Shannon Wiener's diversity index

H_{max} = lnS

lnS = Natural log of the total number of species

The relative frequency of families in which species belong was calculated as;

$$\text{Relative frequency} = \frac{\text{frequency of a species}}{\text{Total frequency of all species}} \times 100 \quad \text{..........} (3)$$

3.3.4 Quantifying the amount of woody species loss due to commercial farming on the sampled farms

Shapefiles of sampled commercial farms were created from the mapping data (i.e. tracked on the field and digitised from Google-earth). The area for the individual sampled commercial farms was calculated in ArcMap software and summed up to get the total size for all sampled farms.

The number of woody species enumerated in the various 25m×25m plots were quantified, based on which the total number of woody species in a hectare of land was extrapolated. The total area sampled for the sixty plots was 37500 m^2 (3.75 Ha). Assuming the commercial farm (Plate 2) lands were as vegetated as the opposing unfarmed vegetation (Plate 3), it is deduced that the species estimated in the unfarmed areas per hectare will be equivalent to the species loss as a result of commercial farming per hectare.

Plate 2: Photographs of some commercial farms

Plate 3: A pictorial representations of the unfarmed vegetation around sampled commercial farms

CHAPTER FOUR

4.0 RESULTS

4.1 The effect of commercial farming on the livelihood of the inhabitants

4.1.1 Socio-demographic characteristics of respondents

4.1.1.1 Respondents' age distribution

The modal age range of respondents for this study was between 34 – 44 years, representing 41 % as shown in figure 4, whiles respondents of age 65 and above recorded the least number of people representing 3.5 %.

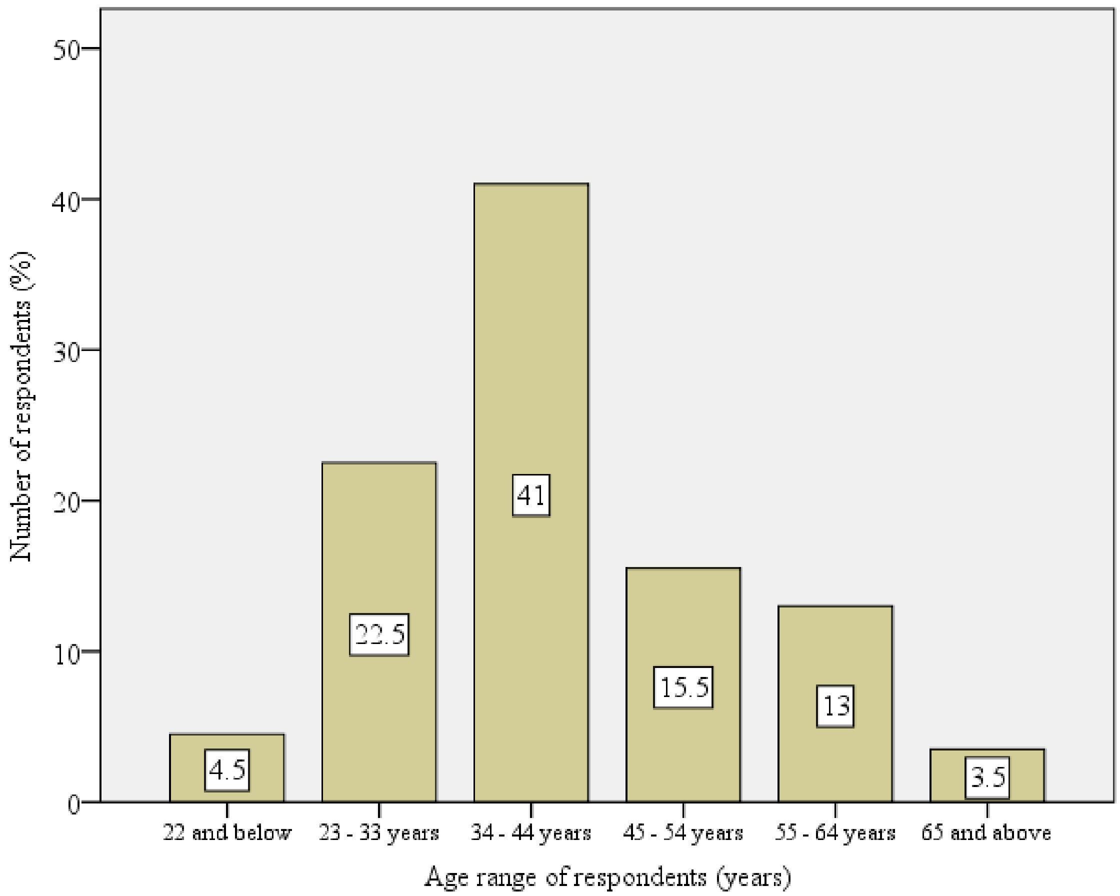

Figure 4: Age distribution of respondents

4.1.1.2 Respondents' level of education

As shown in figure 5, it was discovered that most farmers (62 %) who were involved in this study lacked formal education, and a few respondents (1 %) had formal education up to the postgraduate level.

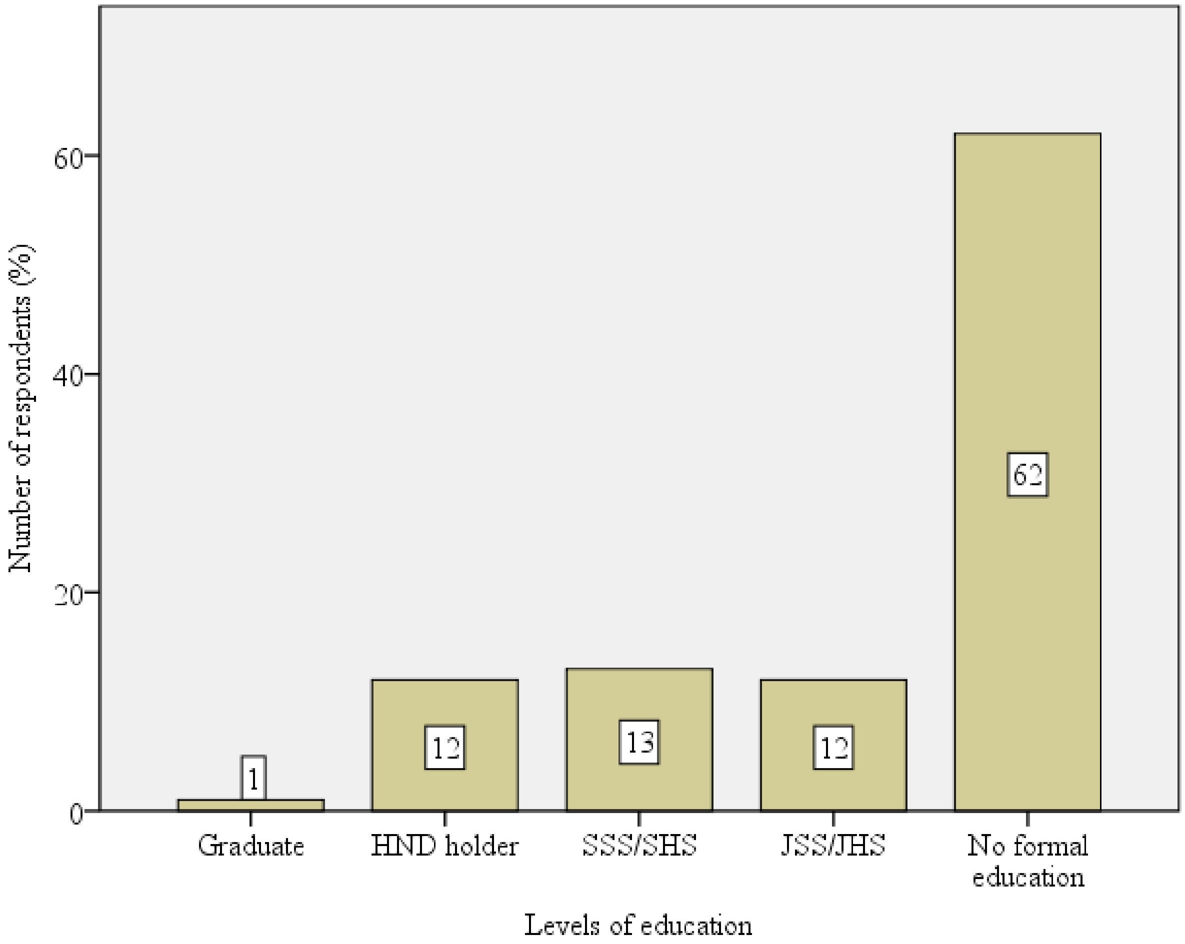

Figure 5: Educational levels of respondents

4.1.1.3 Respondents' farming experience

The figure 6 below shows the number of years that respondents have been active in small-scale farming, thus, crop cultivation and livestock rearing in the Mion District of Ghana. It was seen that 67.5 %, forming the majority of respondents, have been farming for more than ten (10) years in the District, and 14.5 % make up the minor group of respondents who ventured into farming between one (1) and five (5) years.

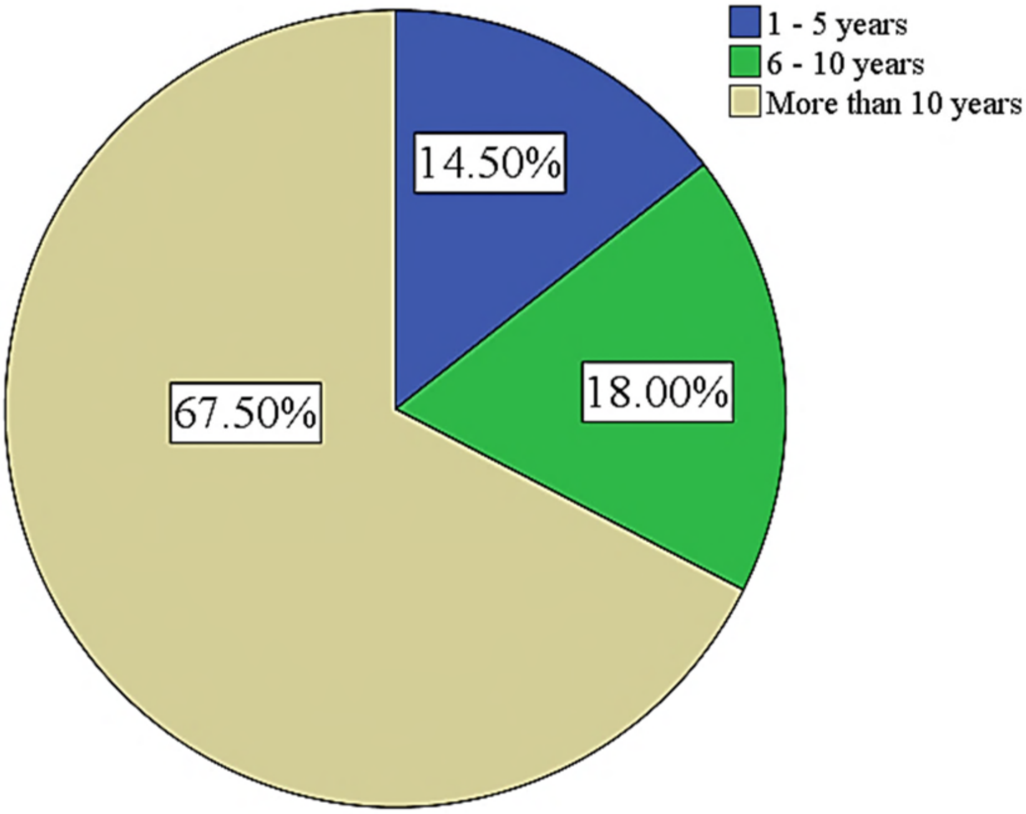

Figure 6: Respondents' active years of farming

4.1.1.4 Respondents' Social Occupation

The main occupation of the respondents for this study was farming (subsistence). However, figure 7 pinpoint their principal sources of income from the various farming sectors. It was revealed that 79.0 % of respondents benefited more from crop farming, and 17.0 % of the people were involved in livestock rearing (figure 7).

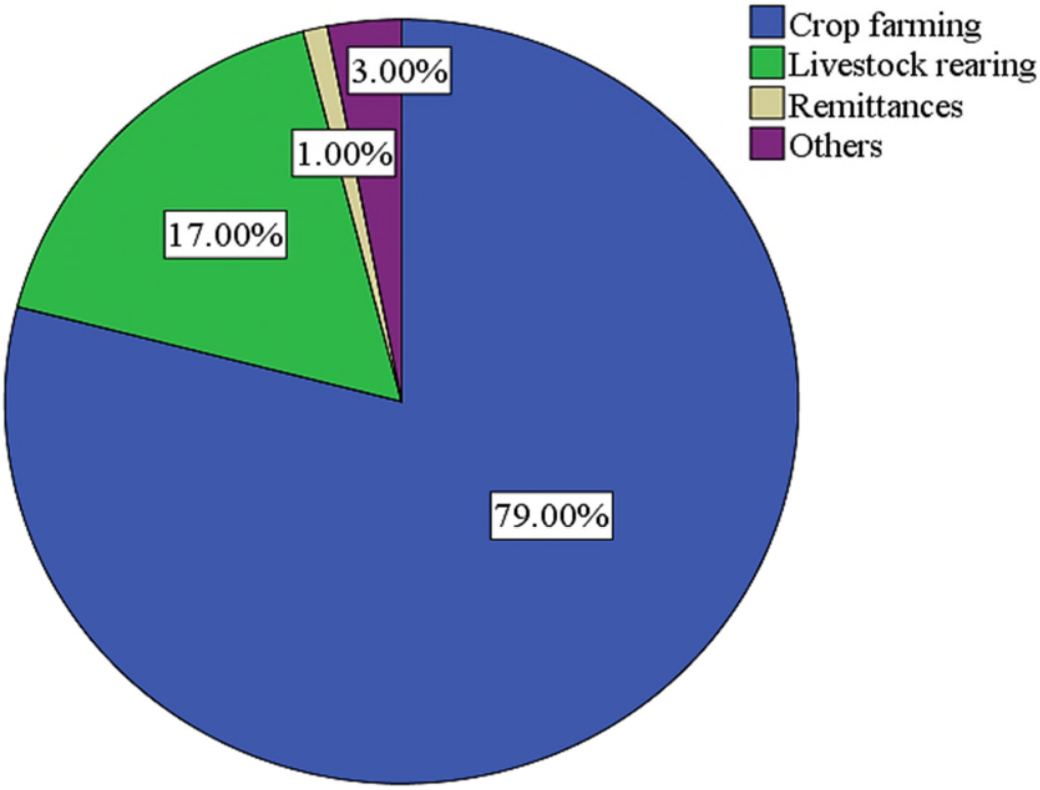

Figure 7: Respondents' major source of income

4.1.2 Problems commercial farmers posed to the inhabitants of Mion District

The results obtained from the administered questionnaire, as shown in figure 8, highlighted some challenges faced by the inhabitants of Mion District. As indicated (figure 8), 53.5 % of respondents said commercial farming has contributed to reducing the quantity of economic trees species, thus; *Vitellaria paradoxa* and *Parkia biglobosa*. Moreover, 33.0 % of respondents also said that commercial farming have caused loss of land space for small-scale farming. They also argued that these large acreages of land occupied by commercial farmers would have been at the disposal of other small-scale farmers in the absence of commercial farming.

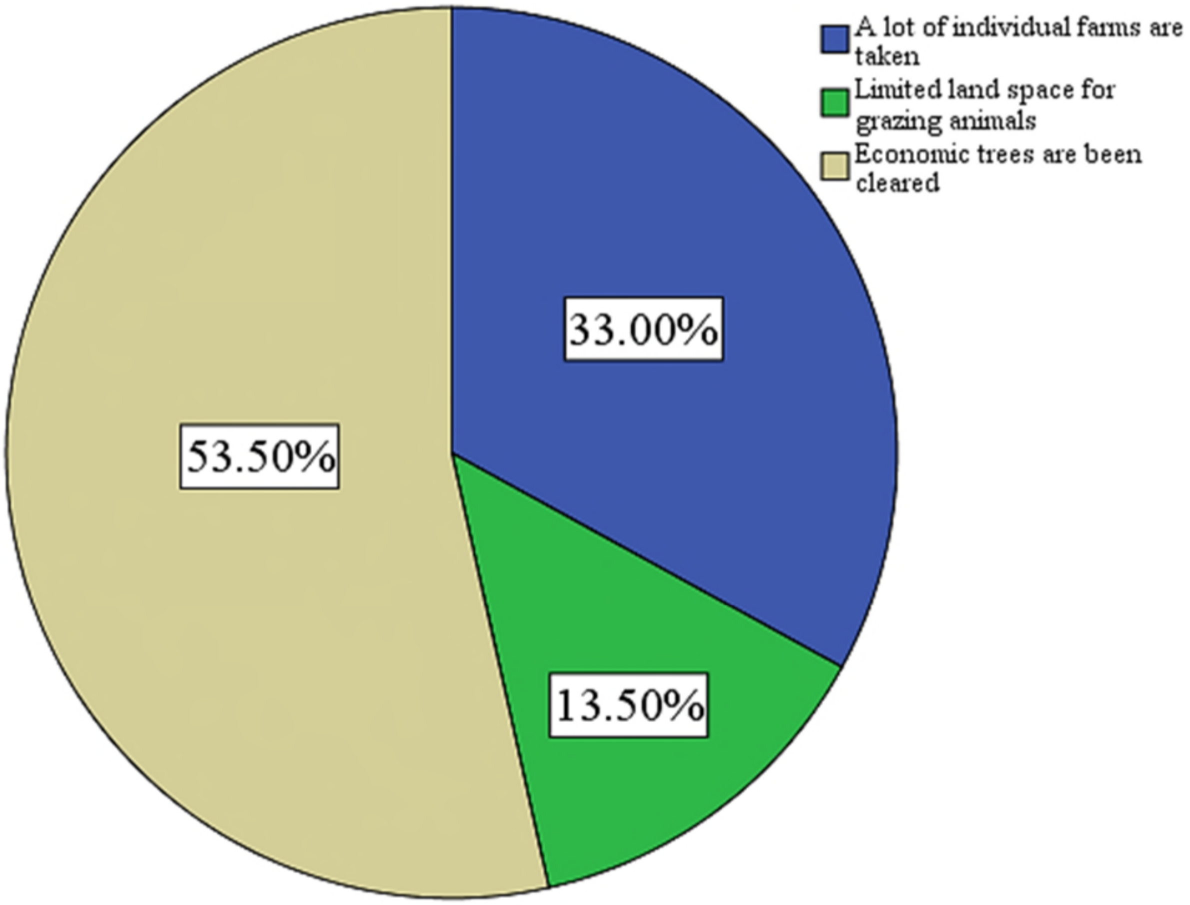

Figure 8: Problems facing the inhabitants of Mion district due to commercial farming

4.1.3 Benefits derived from commercial farming by inhabitants

Despite the problems associated with commercial farming, the inhabitants derived some benefits from commercial farming. Figure 9 shows the contributions of commercial farming to the livelihood of the inhabitants of the District. The results indicate that 50 % of respondents acknowledged that commercial farming had offered employment to some people in close proximity to commercial farming areas. Furthermore, 19 % of respondents said they benefit from fallen woody species by gathering them as firewoods, while 14 % said they burn some of those woods for charcoal.Finally, 17 % of respondents agreed that commercial farmers also offer some level of community support through providing boreholes or dams for some communities and providing their tractors (plough) to assist some subsistence farmers to plough their fields.

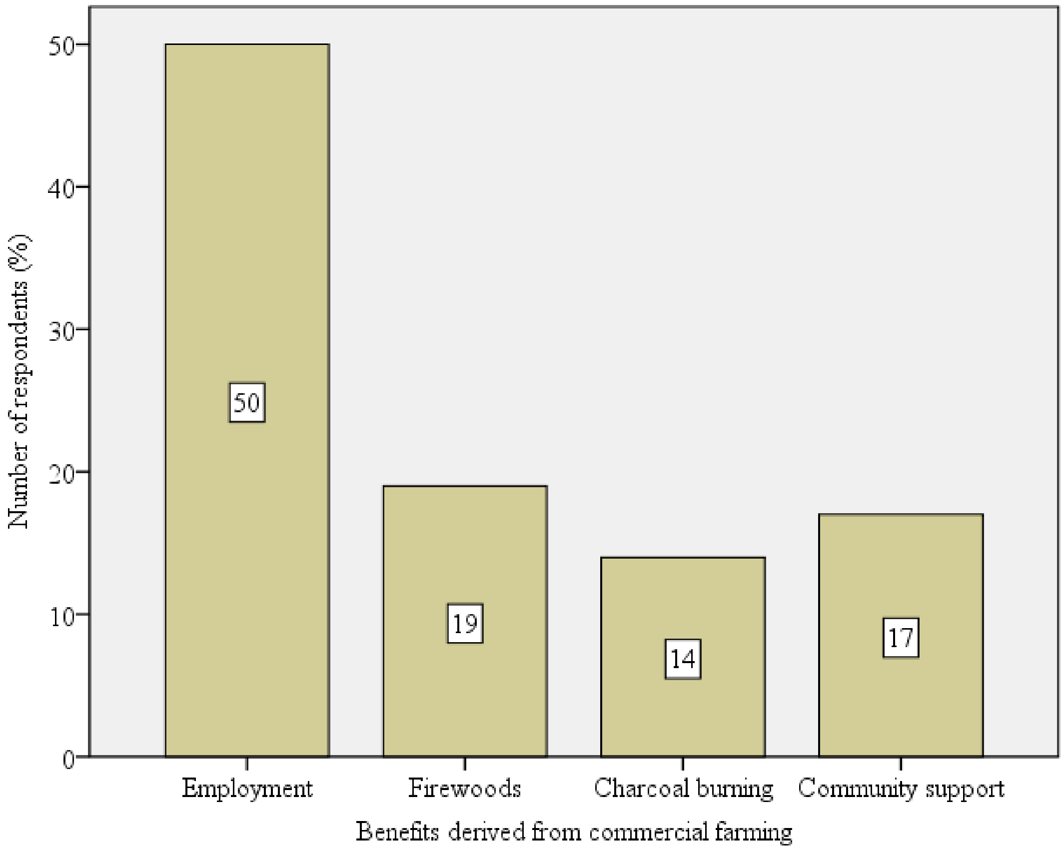

Figure 9: Contributions of commercial farming to the livelihood of the inhabitants

4.2 Vegetation Cover Change Assessment

4.2.1 Post Classification Accuracy Assessment

Post classification accuracy assessment was performed to affirm the relationship between classified thematic and the reference points. The accuracy assessment report has been summarized in Table 1.

Table 1: Accuracy assessment results for the classified data of 2021

LULU	P A (%)	U A (%)	KAPPA STATISTICS
Close woodlands	81.08%	83.33%	0.80
Open woodlands	77.27%	89.47%	0.86
Farmlands	96.30%	87.39%	0.78
Water bodies	53.33%	88.89%	0.88
Bare/build-up	95.83%	79.31%	0.77

P A = Producer accuracy, U A = User accuracy

Overall Accuracy = 86.40% and Overall Kappa Statistics = 0.81

The producer's accuracy indicates how well the analyst classifies the given land cover type pixels. Comparative analyses between the producer's accuracy (PA) and User's accuracy (UA) using close woodlands as an example; the producer's accuracy of this class is 81.08 %, that is, 81.08 % of close woodland areas have been correctly identified as "close woodlands," and User's accuracy of 83.33 % shows that 83.33 % of the areas identified as "close woodland" within the classification are genuinely of that category on the ground.

The occurrence of the higher UA than PA for close woodlands, opened woodlands and water body areas indicate a lesser magnitude of misclassification of those classes, as stated by Nilanchal Patel et al. (2010).

4.2.2 Spatial Distribution of the LULC and LULC Statistics of Mion District

4.2.2.2 Land Use/Cover of Mion District in the Year 2015

Figure 10 shows the classified thematic map of Mion District following five land use/cover classes (close woodlands, open woodlands, farmlands, water bodies, and bare/build-up). Table 2 shows the land use/cover area statistics. In 2015, close woodlands were seen to occupy the most prominent area representing 35.4% with patches that were spatially abundant at the south-northern part of the District. Open woodlands recorded the second-largest area, followed by farmlands occupying 23.4% and 21.5%, respectively, and were uniformly distributed across the District. Areas occupied by water bodies recorded a minor land size of 3.9% and are highly visible at the heart of the District. Meanwhile, bare/build-up areas are randomly scattered in the District with a coverage of 15.8% of the landmass the District.

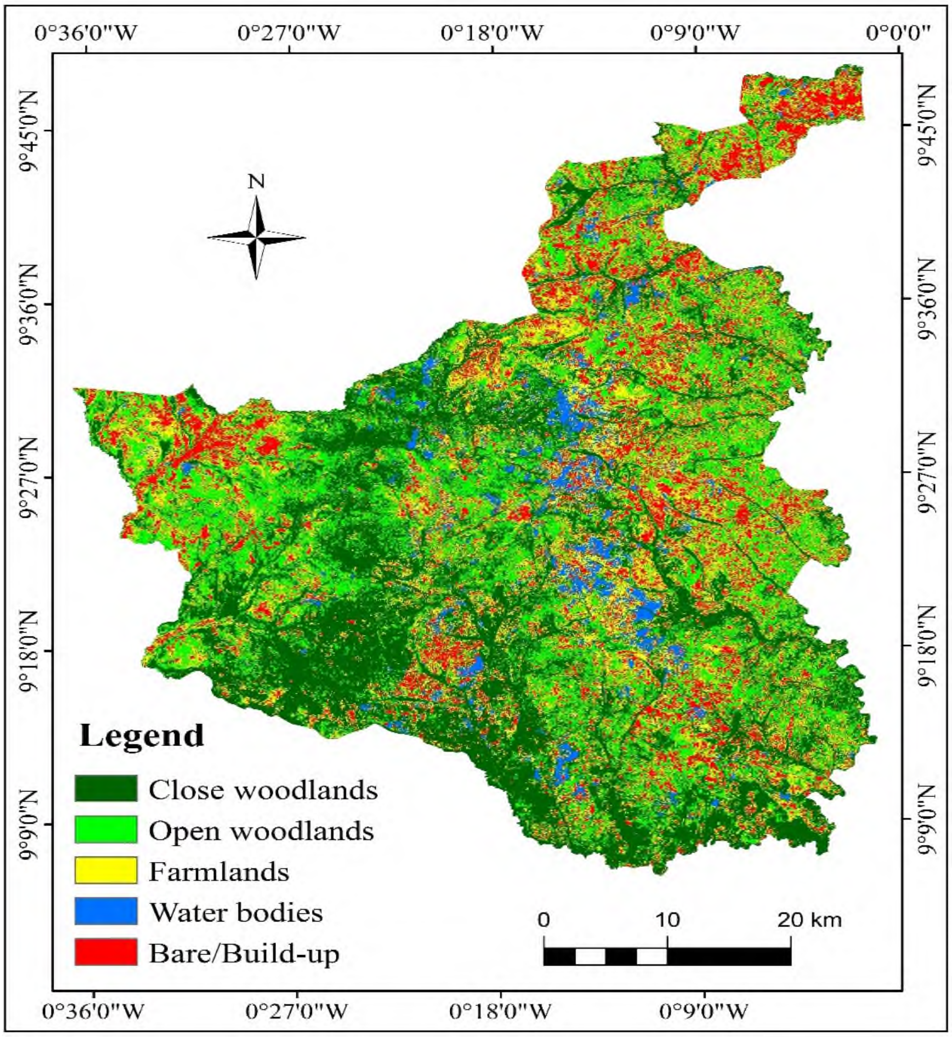

Figure 10: Spatial distribution of LULC in 2015

Table 2: Land use/cover statistics for 2015

LULU	Area (ha)	Area (%)
Close woodlands	91,942.7	35.4
Open woodlands	60,775.4	23.4
Farmlands	55,811.1	21.5
Water bodies	10,253.4	3.9
Bare/Build-up	40,957.2	15.8
Total	**259,739.8**	**100.0**

4.2.2.3 Land Use/Cover of Mion District in the Year 2021

In 2021, the classified thematic map as shown in figure 11 and the land use/cover statistics are shown in Table 3. Close woodlands covered 14.9% of the total area of the district landmass, signifying a reduction by 20.5% of close woodlands from the year 2015.

However, open woodland areas increased by 1.9% of their size in 2015 and are spatially clustered at the northern portion of the District.Correspondingly, there was a massive increase in farmland areas by 23.4% of the total land area of the District, and the farming activities are being carried out more at the southern and northern parts of the District.

On the contrary, water bodies and bare/build-up sites recorded a decline in the landmass of 0.6% and 4.2% correspondingly against the total district landmass in 2015. It was further observed that there was abundant water at the heart (centre) of the District while bare/build-up areas were randomly scattered throughout the district landscape.

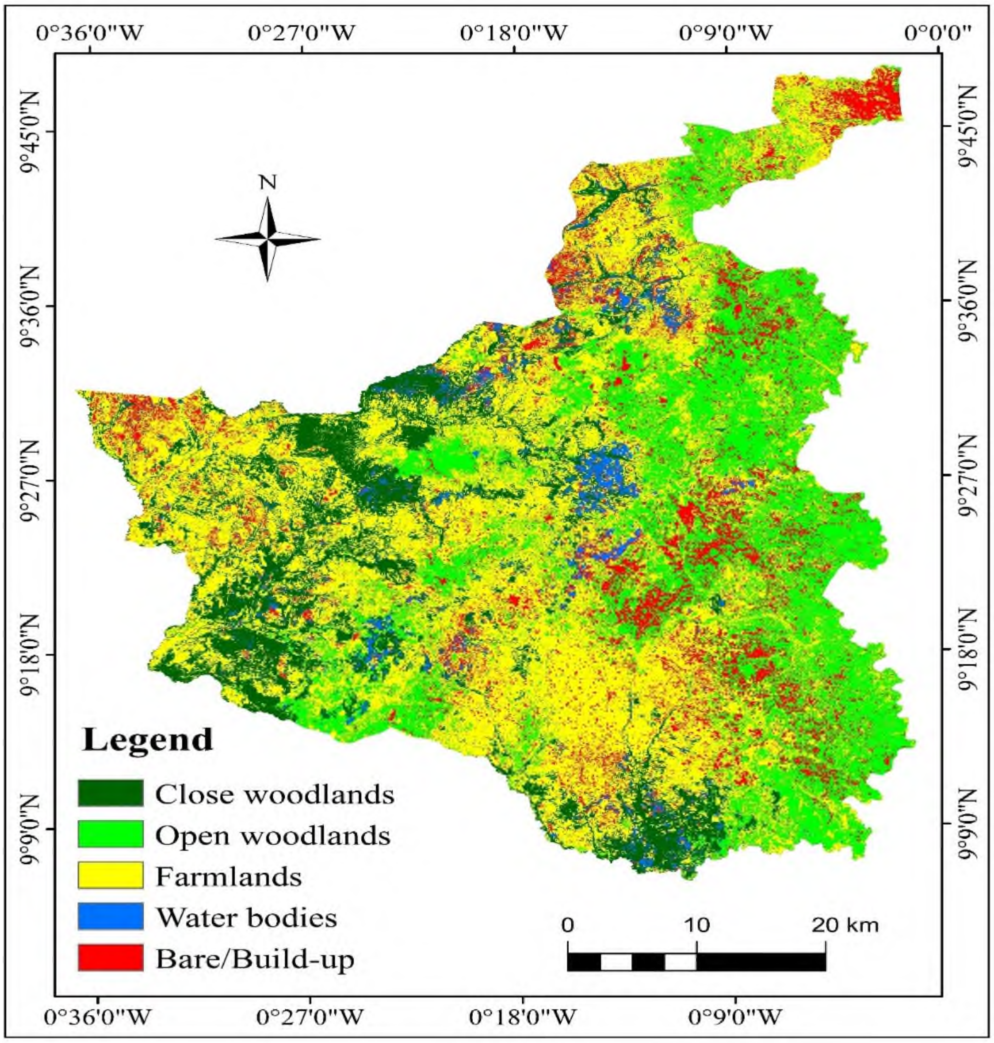

Figure 11: Spatial distribution of LULC in 2021

Table 3: Land use/cover statistics for 2021

LULC	**Area (ha)**	**Area (%)**
Close woodlands	38,704.58	14.9
Open woodlands	65,776.18	25.3
Farmlands	116,564.58	44.9
Water bodies	8,456.48	3.3
Bare/Build-up	30,237.98	11.6
Total	**259,739.8**	**100.0**

4.2.2.4 Landuse/Land cover Change of Mion District from the Year 2015 to 2021

Shown below in figure 12 is the spatial distribution of land use/land cover change in the Mion district, and table 4 highlights the change statistics from 2015 to 2021. A significant amount of each LULC class in 2015 had been converted to other LULC types in 2021, resulting in the decline of the original LULC class in 2015 (Table 2). The unchanged LULC classes correspond to itself, e.g., CW to CW, OW to OW, etc. (Fig12. & Table 4.). The highest LULC class conversion is the transformation of close woodland to farmland, representing 14.9 % of the total land area of the Mion district (Table 4). Also, the least LULC class conversion is the transformation of water bodies to close woodland representing 0.3 % of the District's land size.

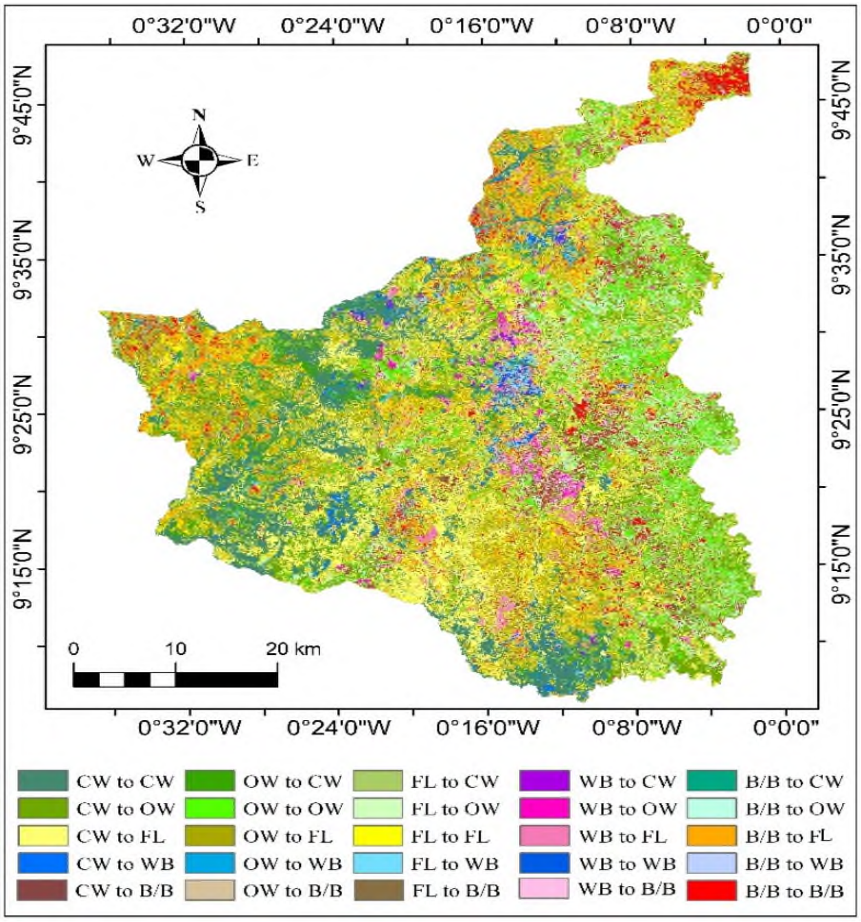

Figure 12: Spatial representation of LULCC from 2015 to 2021

CW = Close woodland, OW = Open woodland, FL = Farmland, WB = Water bodies and B/B = Bare/Build up

Table 4: LULCC statistics from 2015 to 2021

LULCC	Area (Ha)	Area (%)
CW to CW	24758.3	9.5
CW to OW	21415.6	8.2
CW to FL	38582.7	14.9
CW to WB	3077.5	1.2
CW to B/B	4108.7	1.6
OW to CW	8332.5	3.2
OW to OW	17351.6	6.7
OW to FL	28869.9	11.1
OW to WB	1225.1	0.5
OW to B/B	4996.2	1.9
FL to CW	3711.4	1.4
FL to OW	15387.2	5.9
FL to FL	25425.1	9.8
FL to WB	2156.6	0.8
FL to B/B	9130.7	3.5
WB to CW	749.6	0.3
WB to OW	2039.5	0.8
WB to FL	4699.8	1.8
WB to WB	871.3	0.3
WB to B/B	1893.2	0.7
B/B to CW	1152.7	0.4
B/B to OW	9582.4	3.7
B/B to FL	18987.0	7.3
B/B to WB	1126.0	0.4
B/B to B/B	10109.1	3.9
TOTAL	**259,739.8**	**100.0**

4.2.2.5 Agricultural Land Conversions in Mion District from the Year 2015 to 2021

With reference to table 4, all land use/land cover which are not farmlands or had been converted to farmlands in the Mion district in the year 2021 were all grouped and named as "other conversions" as shown in figure 13 (spatial representation of farmland conversions) and table 5 (LULC statistics for farmland conversions).

This section, however, comments on the farmland trajectory within the Mion district since the year 2015. As indicated in table 5, the conversion of closed woodlands to farmlands was the highest (14.9%). On the other hand, the transformation of areas occupied by water bodies (this could be marshy areas and riparian vegetation) to farmland recorded the least change by 1.8%. Aside from these LULC conversions to farmlands, some areas within the District were already classified as farmland in 2015, which occupied 21.5% (table 2). These areas were seen to have reduced to 9.8% (table 5) in 2021.

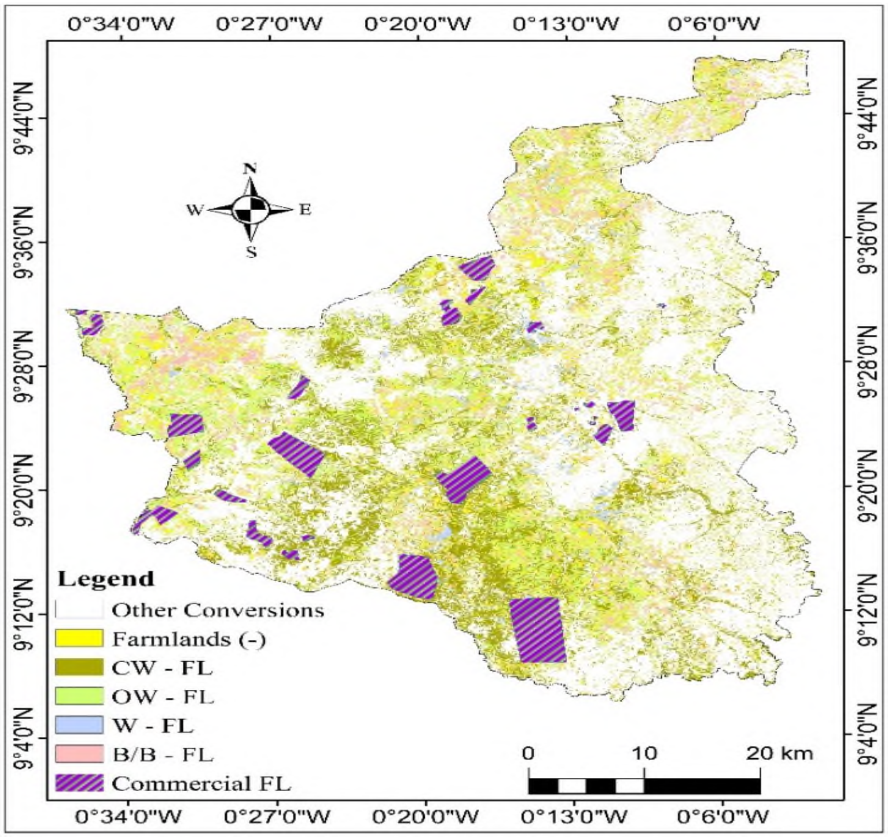

Figure 13: Spatial representation of farmland conversions from 2015 to 2021

Table 5: LULC statistics for farmland conversions from 2015 to 2021

LULU	Area (ha)	Area (%)
Other Conversions	143,175.3	55.1
Farmlands (-)	25425.1	9.8
CW – FL	38,582.7	14.9
OW – FL	28,869.9	11.1
W – FL	4699.8	1.8
B/B – FL	18,987.0	7.3
Total	**259,739.8**	**100.0**
Sampled Commercial FL	**12,084.6**	

CW = Close woodlands, OW = Open woodlands, FL = Farmland, W = Water, B/B = Bare/Build-up (-) = Reduction

4.3 Assessment of woody species diversity and abundance

A total of 41 woody species belonging to 18 families were identified in the unfarmed areas around commercial farms in Mion district (Figure 14).

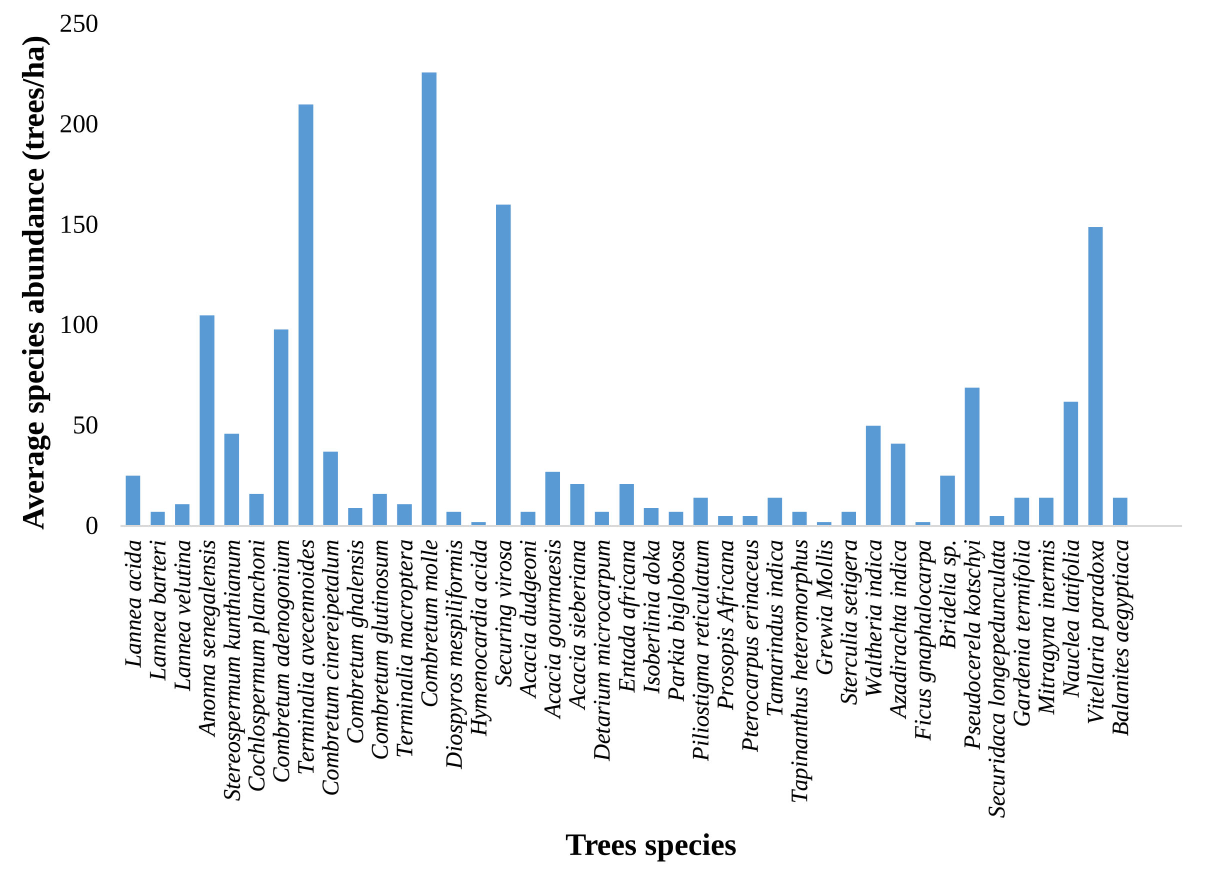

Figure 14: Woody species abundance per hectare in the unfarmed area

Woody species found in the Mion district have a Shannon diversity index (H) of 3.0 and Shannon evenness of 0.81. Woody species in the family Fabaceae had the highest relative frequency, and more than one (1) family recorded the least relative frequency, as shown in figure 15 below. According to the IUCN categorization, *Vitellaria paradoxa is globally vulnerable, and Parkia biglobosa* is globally of least concern.

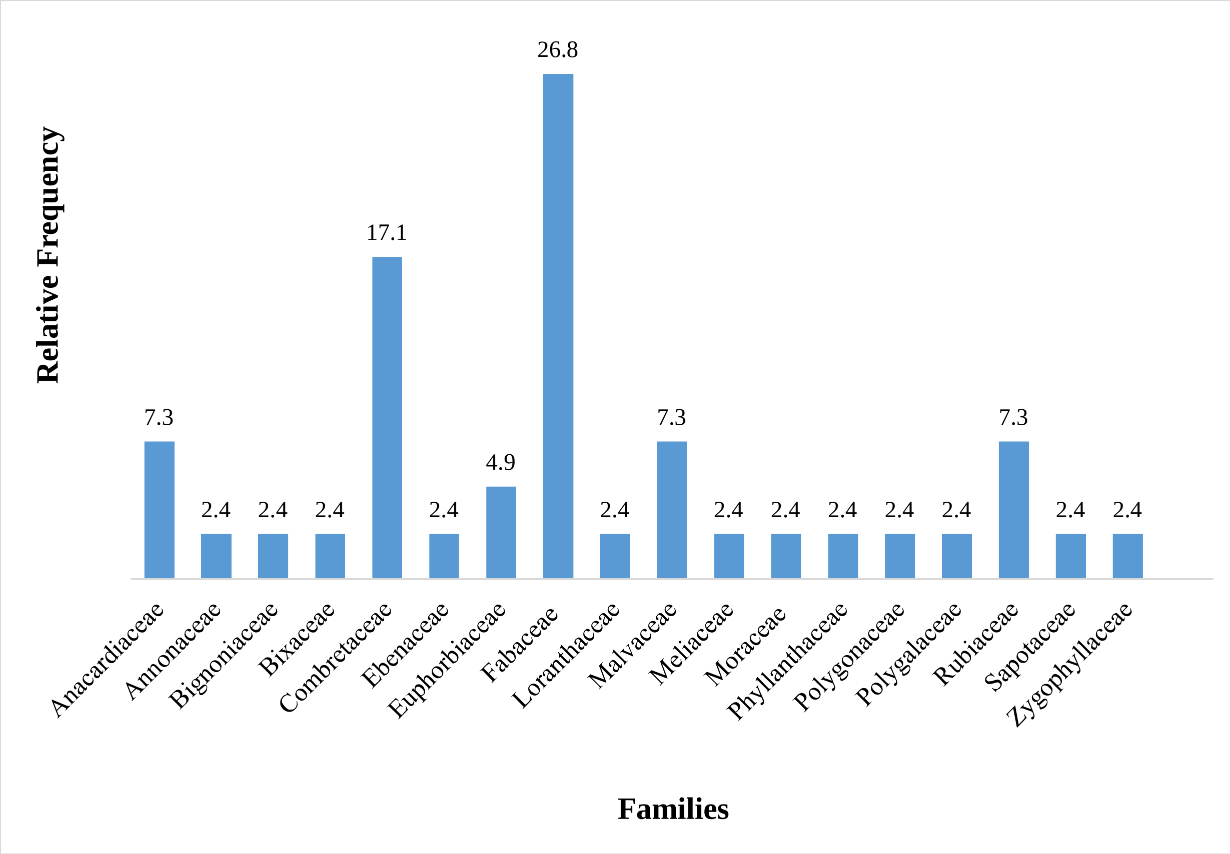

Figure 15: Families of woody species identified with their respective relative frequency

4.3.1 Quantification of the sampled commercial farms in the Mion district

The total estimated area of all the sampled commercial farms used for this study is **12,084.6** hectares.

4.3.2 Quantification of the amount of woody species loss due to commercial farming

The total estimated number of trees, shrubs and saplings per hectare in the unfarmed areas in the Mion district is **1,582**, as indicated in figure 14. *Combretum molle* recorded the highest species abundance of 226 species per hectare. However, *Hymenocardia acida*, *Grewia mollis* and *Ficus gnaphalocarpa* recorded the least species abundance of 2 species per hectare each (Appendix 2). The estimated area for the commercial farmlands sampled for this study is **12,084.6 ha**. Hence, a total of **19117837** individual trees, shrubs and sapling of woody species have been excavated for the establishment of the sampled commercial farms.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Effect of commercial farming on the livelihood of the inhabitants

5.1.1 The negative effect of commercial farming on the livelihood of the inhabitants

The socio-demographic characteristics of 200 sampled small-scale farmers suggest that majority of the farmers were in the middle age group ranging from 34 to 44 years. A similar modal age range i.e. between 36 to 50 years was reported in literature by Abubakari et al., (2022); Morton & Martey, (2021), in the Mion district and Sagnarigu municipality respectively in the northern region of Ghana.

The main occupation of the people involved in this study was small-scale farming thus; crop cultivation and livestock rearing as 67.5% of respondents have been farming for more than ten (10) years in the District. Smallholder livelihoods are primarily dependent on the production and trade of agricultural goods and other ecosystem services (Abubakari et al., 2022; Morton & Martey, 2021). However, land tenure in the Mion district is the customary land tenure system (where lands are owned by stools, skins, families, or clans and are usually held in trust by the chief, or head of the clan, for the benefit of its members), this concurs with Abubakari et al., (2022).

Currently, the Mion district is a serious hub for commercial agricultural activities in the northern region of Ghana and producing crops (mainly, maize, and soybeans) in addition to the rearing of livestock on large acreages. The fact that the commercial farms of the 2021 best farmer in Ghana, Alhaji Mohammed Mashud, are located in the Mion district of northern Ghana, (https://www.graphic.com.gh/news/general-news/alhaji-mohammed-mashud-is-2021-national-best-farmer.html), confirm the degree of commercial farming in the district. According to Amanor & Azindow, (2022); Aminu, (2016), the commercial farmers are not indigenes of the villages in which the activity is occurring but are civil servants who have accumulated enough capital and machinery to invest in large-scale agriculture.

Most chiefs in the Mion district lease their lands to commercial farmers to barter for money, tractor ploughing service, provision of borehole or dam for the community, among others. The leasing of large acreage of fertile savannah woodland by chiefs to civil servant commercial farmers is causing a shortage of fertile farming land for smallholders in the district.This finding is consistent with Amanor & Azindow, (2022); Aminu, (2016) in their respective studies. This implies that if nothing is done to moderate the amount of farming land leased out to large-scale farmers and that available for the small-scale farmer to cultivate their crops, there will not be enough fertile land for subsistence and medium-subsistence farmers and this might lead to local food scarcity since crop produced from commercial farms are exported to the district or regional markets for sale. Moreover, if this practice remains unchecked, there may be friction between the community members and the commercial farmers or their chiefs because community members might fill that their chiefs are releasing land to commercial farmers at the expense of local farmers as reported (Amanor & Azindow, 2022; Aminu, 2016).

Furthermore, commercial agriculture is causing deforestation in the savannah zone due to the excavation of large acreages of savannah woodlands. This activity may affect the local climate since the number of trees available to ameliorate the local climate is reduced. The incidence and frequency of climatic stressors and their associated disturbances are in the ascendency in northern Ghana (Derbile et al., 2021). 53.5 % of respondents said commercial farming has contributed to a reduction in the number of indigenous fruit trees (economic trees) species, especially *Vitellaria paradoxa* and *Parkia biglobosa* which were abundant over the years.These economic trees have contributed to poverty reduction in Africa at large through increases in household incomes from livelihoods that trade in them (Mawa et al. 2021; Derbile et al., 2021; Akrasi et al., 2021; Schreckenberg et al. 2012). The *Vitellaria paradoxa* and *Parkia biglobosa* trees contribute immensely to rural livelihoods (Derbile et al., 2021; Akrasi et al., 2021; Dapilah, 2012). These tree species are often described as the cocoa of the north because of the enormous economic opportunities that they offer to the poor segment of society such as women.

The entire value chain of *Vitellaria paradoxa* and *Parkia biglobosa* are mostly the preserve of women as a result, shea butter and dawadawa production offer avenues for poverty reduction and women's economic empowerment (Derbile et al., 2021; Dapilah, 2012). Aside from the processing of the seeds and nuts, their fruits also serve as food for many households who suffer from food shortages during the hunger season. Despite the enormous services that indigenous economic tree species provide and the direct positive income effect that it has for households who depend on them (Mawa et al. 2021; Kanlisi et al. 2014), their sustainability under climate variability and change is a subject of concern (Derbile et al., 2021; IPCC, 2018).

Moreso, the increasing large-scale farming among other factors in Northern Ghana precisely the Mion district are detrimental to these prime species. This is because, large tracts of the trees are cleared during the land preparation for commercial farming to enable the use of farm machinery

(Dapilah et al., 2018). Hence, this is negatively affecting the role of the economic trees species in providing the livelihood needs of the population living there now as well as their future aspirations. This finding agrees with Dramani et al., (2021) who reported that economically valuable trees such as the Shea and dawadawa trees which were strictly protected in the past are scarce nowadays.

5.1.2 Benefits commercial farming to the inhabitants of Mion district

In spite of the problems associated with commercial farming, it also creates employment for skilled labour such as tractor operators for ploughing, hallowing, planting, harvesting, etc., and unskilled labour mostly the inhabitants of fringe communities to remove stumps and roots left in the soil after ploughing, help convey crop produce to storehouse among others.

As reported in literature, employment is a potential outcome of agricultural commercialisation (Yaro et al., 2017; Cotula et al. 2009). Commercial farming done on an industry level requires lots of skilled and non-skilled laborers resulting in the creation of high employment (Deepak & Devi, 2021). This implies that commercial farming provides a source of income for farmhands thereby reducing unemployment and improving the livelihoods of those employed in this sector. More so, when the trees are excavated during the land preparation for farming, some farmhands and people living in close proximity to commercial farm areas extract these felled trees as fuelwood (either firewood or charcoal) for local consumption and for sale which also generate income and reduce poverty. This finding conforms to Braimoh, (2004) who ascribed that the losses in savannah woodlands are indications of its conversion to other land covers and the production of bulk fuelwood forming about (70%) of Ghana's fuelwood (firewood and charcoal).

Finally, 17 % of respondents agreed that commercial farmers also offer some level of community support through providing boreholes or dams for some communities and offering tractors to assist some small-scale farmers to plough their fields. This finding is in line with literature as reported by Amanor & Azindow, (2022) that local chiefs, landowners and elders who are into small-scale farming encounter difficulty preparing their lands for cultivation hence, they offer land to commercial farmers in exchange for providing ploughing services among others.In this context, if the community support offered by commercial farmers are well negotiated and moderated might stimulate rural economies and contribute to more rapid aggregate growth.

5.2 Land cover Change (gain/loss) from 2015 to 2021

From the results of the land use and land cover classification and post-classification change detection for the six-year period, the landscape of the Mion district has transformed due to the influence of anthropogenic activities.

The findings indicate that closed woodlands were the largest land cover type (35.4%) in 2015, and it was improbable that areas occupied by closed woodland would expand considering the rate at which commercial farmers moved into the district in 2015 and beyond. Hence, in 2021, agricultural land geospatially covered nearly half of the district landmass (44.9%), a doubling of what was present (21.5%) in 2015.

This finding suggests that agricultural land has increased at the expense of both closed woodlands and opened woodlands cover in the district. The outcome of this study confirms the findings reported in literature by (Oduro Appiah et al., 2021; Janssen et al., 2018; Hansen et al. 2013) that agricultural lands are expanding more than the developed land (urban and peri-urban areas). This finding again conforms to a study by Shoyama et al., (2018) that concluded that cropland expansion to meet the growing demand for food is a driving factor in forest degradation. A similar study conducted by Osumanu & Ayamdoo, (2022) in the Bolgatanga Municipality in Ghana also revealed that the savannah agricultural land use has increased by taking over more forest lands. The surge in agricultural activities at the expense of forest or woodland cover could be partly attributed to the Ghana government policy of “Planting for Food and Jobs” which aimed at supporting farmers with agricultural inputs such as mineral fertilisers, improved seeds, pesticides, etc. Contrary to this finding, Braimoh, (2006) argued that firewood collection and charcoal production are the proximate causes of land cover change in Ghana.According to him, fuelwood accounts for more than 70% of the total primary energy supply in Ghana. However, Norris et al., (2010) concluded that remote sensing studies in most of the woody vegetation cover in West Africa, have shown that agriculture is the proximate contributor to forest cover change. Additionally, Jasaw et al. (2015); Antwi et al. (2014); Boafo et al. (2014) associated the decline in forest or woodland cover to pressures from large-scale agricultural development and woodland extraction for firewood, charcoal production, and commercial logging.

The extraction of fuelwood among other factors in the Mion district might have resulted in the depreciation of about 8.2% of closed woodland areas to opened woodland cover as reported by Braimoh, (2004).The current population of Ghana according to the 2021 population and household census is 30.8 million. The increasing population could therefore increase the demand for fuelwood use and agricultural lands at the expense of woodland loss.

5.2.1 Land cover Transition to Agricultural land

The results from the Agricultural land conversion in the Mion district suggest that all the land cover types that were considered in 2015 have partly been transitioned to agricultural land in 2021 and the land cover type that was mostly transformed to agricultural lands was the close and open woodlands.

This could be attributed to the richness of soils to support crop growth and yield. As reported by Shoyama et al., (2018) the growing demand for food has necessitated the expansion of cropland. The conversion of woodlands to agricultural lands in the district corresponds with findings which stated that the expansion in agricultural frontiers has resulted in forest cover vulnerability and degradation (Oduro Appiah et al., 2021; Bourgoin et al., 2020; Vijay et al., 2018).

Human activities such as large-scale agricultural activities, wood extraction, and infrastructure extension are the cause of forest landscape modification (Asare et al., 2021; Kusimi, 2015; Norris et al., 2010). Benefoh et al., 2018 in his study found that the expansion of human settlement is the primary cause of deforestation in the Brong Ahafo and Western Regions of Ghana.

However, this was not the case in the Mion districts based on the findings from this study which revealed that the proximate cause of woodland loss is agriculture activities. This finding concurs with Alo and Pontius (2008); Janssen et al. (2018) who reported that agricultural activities are the primary significant factor for forest cover loss outside of the protected areas. According to Oduro

Appiah et al., (2021), the major causes of land use and land cover dynamics are different in all parts of Ghana.The advent of modern technology in agricultural activities has led to efficient food production but also poses a negative effect on the sustainability of our planet (Reyes et al., 2020). The replacement of woodland with agricultural land might affect their ecosystem services i.e. provision of food and habitat for wild animals, regulating of air quality, ameliorating climate change, protecting water bodies, and many more.However, the results on land cover change (gain/loss) suggest that although agricultural expansion is inhibiting the integrity of woodlands cover in terms of growth, some portions of the woodlands were seen to have recovered from agricultural lands.

Hence, it is most likely for forest land to recover from agricultural activities in the absence of subsequent anthropogenic pressure such as fuelwood extraction, mining, settlement expansion, among others. This assertion is supported by Kusimi, (2015); Mather and Needle, (1998); Nepstad et al., (1991) scholarly work, which reported that forest land cleared for agricultural activities would likely regenerate when activities come to an end, and the agricultural land is abandoned.

5.3 Effect of commercial farming on woody species diversity and abundance

5.3.1 Assessment of woody species diversity and abundance

The finding from the species diversity index using the Shannon-Wiener diversity index reported an index of 3.0 and evenness of 0.8 for the Mion district. This index accounts for the abundance and evenness of the species present (Sarma & Dhruba, 2015). The value of the Shannon Weiner diversity index usually ranges between 1.5 and 3.5, and in some rare cases, the value may exceed 4.5 (Coulibaly et al., 2021; Gaines et al., 1999). The larger the Shannon value, the higher the species diversity and evenness and vice versa. Hence, the 3.0 species diversity and 0.8 evenness recorded in the Mion district is considerably high.A similar study conducted by Coulibaly et al., (2021), in the Sudan Savannah (i.e. Bawku, Binduri, Garu, and Pusiga) recorded a Shannon index of 2.21, 2.48, 1.19, and 1.09 respectively for forest reserves with these areas of interest, representing moderate species diversity. However, the Mion district is located in the Guinea Savanna so it is expected to have high species diversity than in the Sudan Savannah. This finding is in line with Tom-Dery et al., (2013) who reported a Shannon index of 3.5 in a study carried out in Kenikeni forest reserve in the Guinea Savannah of Ghana. Additionally, a study conducted by Attua & Pabi, (2013) in the northern forest-savanna ecotone of Ghana also reported a Shannon index of 3.39 in the near Savannah ectotone. Similarly, Mensah et al., (2016) also recorded a Shannon evenness of 0.8 for woody species in both fallow lands, and sacred groove/reserves in five communities in the Tolon district (guinea savannah) of Ghana. According to Roth (1994), the evenness value also inform the degree of pressure on a field and indicate how equitable the species are spatially distributed.

Therefore the 0.8 evenness recorded in this finding is an indication some woodland areas in the district are undisturbed and well distributed spatially. The undisturbed woodland areas within the district should be treated as a high conservation value due to their direct role in the provision of basic ecosystem services as well as possessing prime resources such as Shea and Dawadawa to help meet basic needs of local communities who engage in the value chain of these prime resources.Furthermore, the study identified woody species in the family Fabaceae (26.8%) and Combretaceae (17.1%) as the most dominant families in the district. This assertion concurs with the findings of Asase et al. (2009) and Asase and Oteng-Yeboah (2007) that the Fabaceae and Combretaceae were the dominant tree families in guinea savanna vegetation.

The study also found that leguminous trees such as the *Acacia* spp belonging to family Fabaceae were abundant in the district and looking at the role they play in maintaining nitrogen balance of agro-ecosystems for improved crop yield. This could be the reason why large-scale farmers move to the Mion district to farm for which reason they are protected and managed on farms. Over the years, economic trees like *Vitellaria paradoxa* and *Parkia biglobosa* were managed by local people in order to serve their livelihood needs (Attua & Pabi, 2013).However, the finding of this study revealed that these economic trees have spatially reduced. About 53.5% of respondents acknowledged that the quantity of these species have reduced due to the introduction of large-scale farming to the district. This finding is consistent with the findings of Dramani et al., (2021); Mensah et al., (2016); Aniah et al., (2014) that economically valuable trees such as the Shea and Dawadawa trees which were strictly protected in the past are scarce nowadays.

The results obtained after estimating the effect of commercial farming on woody species in the Mion district revealed that not only the commercial trees have reduced over the years but also other woody species as well. Their reduction may not have been noticed by the inhabitants of the district because they do not directly depend on them. Based on the thirty (30) commercial farms (estimated area = 12,084.6 ha) sampled for this study, it was estimated that about **19117837** individual trees, shrubs and saplings of woody species have been excavated due to commercial farming. This implies that if the extent of large-scale farming is not moderated to create a balance between the cultivation of crops and the conservation of the savannah woodlands, the integrity of the guinea savannah woodland would be lost in the subsequent years and this may lead to local climate variability. This claim is supported by Owusu et al., (2021) that the farming households in the Guinea Savannah zone tends to be more vulnerable to climate stress. This climate variability in not prevented by safeguarding the trees species would later affect food security as reported by Baffour-Ata et al., (2021)

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Based on the qualitative and quantitative analysis of the gathered data, it was concluded that commercial farming has both direct and indirect impacts on the livelihood of people living in close proximity to commercial farming areas. The results from the qualitative analysis indicate that large acreage of fertile lands are leased to commercial farmers by chiefs in exchange for goods and services at the expense of smallholder farmers who equally need fertile land for subsistence farming. Aside from the increasing land shortage for smallholder farmers, commercial farming is deforestating the savannah woodland due to the excavation of large acreages of woody species (including economic tree species) to pave way for the use of farm machinery.

These economic trees have contributed to poverty reduction in Africa at large through increases in household incomes for those who trade in them. The increasing large-scale farming among other factors in the Mion district is detrimental to these economic species.

Further finding indicate that; inspite of the problems associated with commercial farming, it also creates employment for some inhabitants of the district. It employs both skilled and unskilled manpower which help to improve their livelihoods. Also, people living in close proximity to commercial farm areas extract the excavated trees as fuelwood for local consumption and for sale which also generate income and reduce poverty. Again, commercial farmers also offer some level of community support through providing boreholes or dams for some communities and offering tractors to assist some small-scale farmers to plough their fields.

The results from the quantitative analysis (land use and land cover classification and post-classification change detection) indicate that, the landscape of the Mion district has transformed due to the influence of anthropogenic activities. The findings indicate that close woodlands were the largest land cover type (35.4%) in 2015 but in 2021, agricultural land covered nearly half of the district landmass (44.9%), a double of what was present (21.5%) in 2015.

The woody species survey recorded a total of 41 woody species belonging to 18 families which were identified in the unfarmed areas around sampled commercial farms. Based on the thirty (30) commercial farms (estimated area = 12,084.6 ha) sampled for this study, an estimated **19117837** individual trees, shrubs and saplings of woody species were excavated due to commercial farming.

6.2 Recommendations

1. There is therefore the need for stakeholders to establish policies to help moderate the amount of farming land leased out to large-scale farmers and that available for the small-scale farmers to cultivate their crops to avoid future friction between land users.
2. There should be proper agreement and documentation of royalties that commercial farmers are to provide to the local people for using their land to stimulate rural economies and contribute to more rapid aggregate growth.
3. There is the need for stakeholders to develop measures to ensure sustainable agriculture whiles preserving woody species for their enormous contribution such as provision, regulation and protection functions to the ecosystem to be achieved.
4. There is the need for future studies to use a different algorithm such as random forest classification to ascertain the effect of commercial farming on the woodland of Mion district.

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APPENDIX

Appendix 1: Woody species and their families in Mion district

FAMILY	SPECIES (Local name)	SPECIES (Scientific name)
Anacardiaceae	Sinsabga	*Lannea acida*
	Sinsabgbetilga	*Lannea barteri*
	Sinsabpiegu	*Lannea velutina*
Annonaceae	Bulunbugu	*Anonna senegalensis*
Bignoniaceae	Zugubetia	*Stereospermum kunthianum*
Bixaceae	Beblituturi	*Cochlospermum planchoni*
Combretaceae	Yulinga	*Combretum adenogonium*
	Kori	*Terminalia avecennoides*
	Yurina	*Combretum cinereipetalum*
	Yulinpeli	*Combretum ghalensis*
	Yugkpali	*Combretum glutinosum*
	Koriyang	*Terminalia macroptera*
	Gbiliga	*Combretum molle*
Ebenaceae	Gaa	*Diospyros mespiliformis*
Euphorbiaceae	Dankunga	*Hymenocardia acida*
	Sugar	*Securing virosa*
Fabaceae	Gotye	*Acacia dudgeoni*
	Tarifa	*Acacia gourmaesis*
	Gopuhigu	*Acacia sieberiana*
	Kpaliga	*Detarium microcarpum*
	Chelinchegu	*Entada africana*
	Kpalsogu	*Isoberlinia doka*
	Doo	*Parkia biglobosa*
	Banga	*Piliostigma reticulatum*
	Nanzyili	*Prosopis Africana*

	Nee	*Pterocarpus erinaceus*
	Puga	*Tamarindus indica*
Loranthaceae	Tohabaginga	*Tapinanthus heteromorphus*
	Yoga	*Grewia Mollis*
	Pulunpung	*Sterculia setigera*
	Budoni	*Waltheria indica*
Meliaceae	Nyima	*Azadirachta indica*
Moraceae	Kinking	*Ficus gnaphalocarpa*
Phyllanthaceae	Bamboo	*Bridelia sp.*
Polygonaceae	Sigrili	*Pseudocerela kotschyi*
Polygalaceae	Pelican	*Securidaca longepedunculata*
	Lazuli	*Gardenia termifolia*
	She	*Mitragyna inermis*
Rubiaceae	Gulungung	*Nauclea latifolia*
Sapotaceae	Tanga	*Vitellaria paradoxa*
Zygophyllaceae	Giga	*Balanites aegyptiaca*

Appendix 2: Table of estimated woody species per hectare

Family	**Species**	**Average Species per plot**	**Species Abundance per ha**
Anacardiaceae	*Lannea acida*	1.6	25
	Lannea barteri	0.4	7
	Lannea velutina	0.7	11
Annonaceae	*Anonna senegalensis*	6.6	105
Bignoniaceae	*Stereospermum kunthianum*	2.9	46
Bixaceae	*Cochlospermum planchoni*	1	16
Combretaceae	*Combretum adenogonium*	6.1	98
	Terminalia avecennoides	13.1	210
	Combretum cinereipetalum	2.3	37
	Combretum ghalensis	0.6	9
	Combretum glutinosum	1	16
	Terminalia macroptera	0.7	11
	Combretum molle	14.1	226
Ebenaceae	*Diospyros mespiliformis*	0.4	7
Euphorbiaceae	*Hymenocardia acida*	0.1	2
	Securing virosa	10	160
Fabaceae	*Acacia dudgeoni*	0.4	7
	Acacia gourmaesis	1.7	27
	Acacia sieberiana	1.3	21
	Detarium microcarpum	0.4	7
	Entada africana	1.3	21
	Isoberlinia doka	0.6	9
	Parkia biglobosa	0.4	7
	Piliostigma reticulatum	0.9	14
	Prosopis Africana	0.3	5
	Pterocarpus erinaceus	0.3	5

	Tamarindus indica	0.9	14
Loranthaceae	*Tapinanthus heteromorphus*	0.4	7
Malvaceae	*Grewia Mollis*	0.1	2
	Sterculia setigera	0.4	7
	Waltheria indica	3.1	50
Meliaceae	*Azadirachta indica*	2.6	41
Moraceae	*Ficus gnaphalocarpa*	0.1	2
Phyllanthaceae	*Bridelia sp.*	1.6	25
Polygonaceae	*Pseudocerela kotschyi*	4.3	69
Polygalaceae	*Securidaca longepedunculata*	0.3	5
Rubiaceae	*Gardenia termifolia*	0.9	14
	Mitragyna inermis	0.9	14
	Nauclea latifolia	3.9	62
Sapotaceae	*Vitellaria paradoxa*	9.3	149
Zygophyllaceae	*Balanites aegyptiaca*	0.9	14

Appendix 3: List of sampled commercial farms

S/N	Farm Name	Crop	Area (ha)	Latitude	Longitude
1	Afront Farms	Ric and Soyabeans	19.9	9.5281696	-0.143664
2	Mc Bonsu Farms	Rice	43.6	9.4221497	-0.201821
3	Winning Farms	Soybeans and Maize	9.5	9.4173403	-0.211363
4	Kolada Farms	Soyabeans	119.9	9.2624903	-0.437489
5	Sunshine Farms	Maize and Soyabeans	55.2	9.2805004	-0.423906
6	Puzuri Farms	Rice, Maize and Soyabeans.	132.6	9.2973804	-0.554484
7	Asimbeya Farms	Maize and Rice	30.8	9.4047804	-0.19849
8	Express Phenomena Farms	Maize and Rice	603.8	9.4108105	-0.176024
9	Farmer World Farms	Groundnuts, Maize and Soyabeans.	669.2	9.4025402	-0.519381
10	Grazie Farms	Rice,Soyabeans.	41.1	9.52425	-0.60065
11	Prosperity Farms	Groundnuts,Maize and Millet	259.4	9.51056	-0.590757
12	Greenbelt Farms	Maize, Rice and Soyabeans.	221.7	9.4422398	-0.429847
13	M.M.Awal Farms	Rice,Soyabeans,Maize and Yam.	818.7	9.3656797	-0.425385
14	Brakatu Farms	Soyabeans and Maize.	345.8	9.5215998	-0.310347
15	Ave Maria Farms	Yam,Maize and Groundnuts.	137.6	9.5402203	-0.290746
16	Green Gold	Soyabeans.	562.7	9.5696402	-0.288285
17	Kujo Abimash Farms	Soyabeans	117.4	9.5058498	-0.243643
18	A. Rahaman Farms	Groundnuts, Maize and Rice.	222.5	9.3900499	-0.191134
19	Shaduwa Farms	Rice,Maize and Rice	94.3	9.4013395	-0.247447
20	Zeera Farms	Soyabeans and Maize.	833.6	9.3481798	-0.295125
21	Olu Farms	Soyabeans and Maize	853.5	9.2282104	-0.341552
22	Explosive Farms	Soyabeans and Rice.	352.1	9.3060198	-0.541075
23	Seini Farms	Maize and Groundnuts	191.4	9.36446	-0.514116
24	Tapei kukuo Farms	Rice, Soyabeans and Maize.	198.9	9.3254805	-0.485424
25	Chief Jesiwuni Farms	Rice,Soyabeans and Maize	289.2	9.2842398	-0.462745
26	Kujo Abimash Farms	Maize and Soyabeans	1807.6	9.1662703	-0.242009
27	Kujo Abimash Farms	Maize Soyabeans and Maize	1339.9	9.1999702	-0.246071

28	Timtooni Farms	Yams,Soyabeans and Maize	524.3	9.3336096	-0.310769
29	Dagara Farms	Soghum,	744.5	9.2490501	-0.337987
30	Padez Farms	Rice, Maize and Soyabeans.	444.0	9.3810701	-0.442128

Appendix 4: Questionnaire used for the qualitative data collection

UNIVERSITY FOR DEVELOPMENT STUDIES

FACULTY OF NATURAL RESOURCES AND ENIVIRONMENT

DEPARTMENT OF ENVIRONMENT AND SUSTAINABILITY SCIENCES

Dear Respondent:

I am carrying out a study on the topic "the effects of Commercial Farming on the inhabitants and the woody species diversity of the Mion District in the Northern Ghana" This study is part of my Master of Philosophy Thesis. Your active participation is key. The outcome of this study will contribute knowledge to existing literature on the effects of commercial farming on the inhabitants and woody species diversity.

I do understand that time is valuable, the exercise will take about 30 minutes of your time. Information gathered however, will be treated confidential, and the results will be presented without personal attack.

Thank you for partaking in this study.

Shani Abukari Aduwa: 02487753391.

SECTION A: SOCIO DEMOGRAPHIC CHARACTERISTICS OF FARMERS

1. Sex:

    1 [ ] Male

    2. [ ] Female

2. Age

    [ ] 22 and below

    [ ] 23 – 33 years

    [ ] 34 – 44 years

    [ ] 45 – 54 years

    [ ] 55- 64 years

    [ ] 65 and above

3. Marital status [ ] Single [ ] Married [ ] Divorced [ ] Widowed
4. How many wives do you have?..
5. How many children do you have?...
6. How many of your children are in school?.......................................
7. What is your level of education?

    [ ] Degree holder

    [ ] HND

    [ ] Postgraduate

    [ ] SSS/SHS

    [ ] JSS/JHS

    [ ] No formal education

8. What is your religious affiliation?

    [ ] Islam

    [ ] Christianity

    [ ] Traditional

    [ ] None

9. What is your ethnic background?...............................

10. Are you a member of any farmer based organization?

    [ ] Yes

[ ] No

SECTION B: FARMING CHARACTERISTICS

11. How long have you been farming? a) <1 year b) 1-5 years c) 6-10 years d) > 10 year

12. What are your sources of income?

[ ] Crop farming

[ ] Livestock rearing

[ ] Remittances

What is your estimated yield in the past planting season? Fill in the table below

Staple crop	**Acreage in acres**	**Yield in kg**	**Quantity consumed**	**Quantity sold**
Maize				
Millet				
Sorghum				
Rice				
Yam				
Cassava				
Groundnut				
Soya bean				
Cowpea				
Others (specify)				

13. What is your estimated livestock output in the past season? Fill in the table below.

Type	**Number**	**Quantity consumed**	**Quantity sold**
Cattle			
Sheep			
Goat			
Guinea fowls			
Local fowls			
Others (specify)			
Groundnut			
Soya bean			
Cowpea			
Others (specify)			
Others (specify)			
Others (specify)			

14. Do you have separate farms? Choose what suit your number of farms.

a) 1 b) 2 c) 3 d) 4 e) 5 and above.

15. What is the estimated size of your farm(s)? a) < 1 acre b) 1-5 acres c) 6-10 acres d) > 10 acres

16. What is your mode of production? a) Labour intensive b) Capital intensive c) Both

17. What form of labour do you use on your farm(s)?

[ ] Owner Only

[ ] Nnoboa

[ ] Family

[ ] Hire Labour

[ ] Others (Specify) …………

18. Which of these land preparation methods do you use?

[ ] Slash and burn

[ ] ecological farming

[ ] Tillage

[ ] Others (specify)

19. Do you do other economic activities aside of farming?

a. YES

b. NO

20. If YES, Please tick as many to suit your choice

i. Artisans only (Type of produce)

a. Carpentry

b. Metal work

c. Basketry

d. Bead making

e. Sculpturing

f. Fitting

Others……………………

ii. Services only (tick the services rendered)

a. Seamstress

b. Hair dressing

c. Food vending

d. Retail shop

e. Civil service

Others …………………

21. If NO, give reasons

a. Restrictions by institutions

b. Income is enough in side business

c. Does not have the means to venture into activities

d. Limitations by time

e. Not interested in any other activity outside farming.

Challenges of commercialization on the socio-economic and demographic development of the inhabitants in the Mion District of the Northern

22. Does changing Savannah woodland cover have any effect on your livelihood?

a. YES

b. NO

23. If the answer is YES, state your concern

i)………………………………………………………………………………………

ii)………………………………………………………………………………………

iii)………………………………………………………………………………………

24. What has been done about your stated concern?

i)………………………………………………………………………………………

ii)………………………………………………………………………………………

iii)………………………………………………………………………………………

The extent to which commercialization affects other sectors and economic activities in the study area.

Which sector has the commercial farming affected in your community?

i)………………………………………………………………………………………

ii)………………………………………………………………………………………

iii)………………………………………………………………………………………

SECTION C

1. What was the vegetation cover in this area 10 years ago?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

2. What is the current vegetation cover in this area?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

3. Mention the benefits area derives from the commercial farmers?

i)……………………..………………………………………………………………

.ii)………………………………..………………………………………………...

iii)………………………………………………………………………………………

4. How many people in the area has commercial farmers offered employment to?

5. How many people has the commercial farmers made unemployed?

…………………………………………………………………………………………………
…………………………………………………………………………………………………

6. Why do you think they are unemployment?

i)…………………………………………………………………………………………………

ii)…………………………………………………………………………………………………

7. What livelihood safeguarding programs have been put in place to give alternative livelihoods to those affected by the commercial farming?

i)…………………………………………………………………………………………………

ii)…………………………………………………………………………………………………

iii)………………………………………………………………………………………………

8. State the challenges that the commercial farming pose to the socio-economic activities in the area.

i)…………………………………………………………………………………………………

ii)………………………………………………………………………………………………..

iii)……………………………………………………………………………………………….

9. What trees are common in your locality?

10. Mention the economic trees in your locality

11. Which trees are considered commercial?

12. What economic gains do you get from the commercial trees mentioned above?

13. Apart from the economic gains, what way or ways do benefit from the trees again?

14. Do trees and shrubs have any impact on the biodiversity? Yes or No

If yes in which ways?

15. Mention the names of the non-commercial trees and shrubs you know
16. How do you use them for in your household
17. How does commercial farming affect the population of your commercial and non-commercial trees and shrubs?

18. Does commercial farming have any effect on the biodiversity of the area?

Yes /No

   a. If no, state the positives
   b. If yes, how?

19. Do you for see any danger on the environment in the near future as a result of the activities of the commercial farming? Yes /No

   a. If no mention the fortunes
   b. If yes mention some of the dangers

20. How do you intend to prevent the dangers?

21. Mention the examples of the following on floral biodiversity:

   a. Commercial trees
   b. No-commercial trees
   c. Shrubs
   d. Grasses

22. Enumerate the economic importance/uses of the following mentioned in question 21 above in the society

   a. Commercial trees
   b. Non-commercial trees
   c. Shrubs
   d. Grasses

Thank you