IDENTIFYING FARMERS MOTIVATION TO RETAIN SHADE TREES FOR REDD+ IMPLEMENTATION IN COCOA LANDSCAPE IN GOASO FOREST DISTRICT, GHANA

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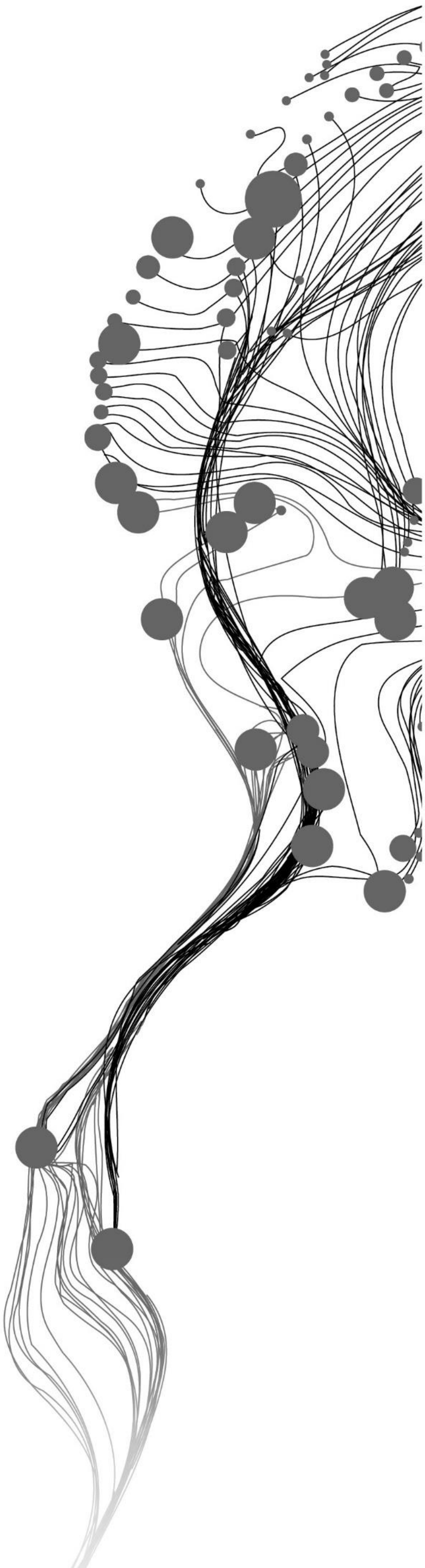

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ABSTRACT

Deforestation is an environmental issue impacting climate, regional geochemical cycles and biodiversity. Cocoa (Theobroma cacao) cultivation is thought to have contributed considerably to forest degradation and deforestation in Ghana. Cocoa is a major cash crop cultivated mostly in the forest zones of the country. The main farming systems are traditional and hybrid. The traditional system supports a high density of shade trees and the hybrid have little or no shade trees. The internal factors such as perception, knowledge and the attitude of the farmers and the external factors such as land tenure, economic incentives, tree tenure determine the motivation of farmers to retain or remove shade tree in the cocoa field.

The cocoa landscape is noted for carbon storage. Carbon stock in cocoa agroforestry system is essential for climate change mitigation. Ghana recognises this important contribution of the cocoa agroecosystem. Hence, a nested approach for REDD+ implementation is adopted by Ghana. The approach seeks to implement REDD+ in cocoa landscape and then to be upscaled to other ecological zones of Ghana. The implementation of REDD+ in the cocoa landscape requires retention of shade trees on cocoa farms for carbon monitoring.

In carbon monitoring, there is the need to safeguard the shade trees and improve carbon stock in the cocoa landscape. Hence, understanding and identifying the motivational factors that influence retention or removal of shade trees from cocoa landscape was crucial for carbon monitoring. The main aim of this study was to examine the motivational factors for retention and removal of shade trees from the cocoa landscape.

A semi-structure questionnaire was administered to local cocoa farmers to identify the motivational factors influencing retention and removal of shade trees on cocoa fields. Enumeration of shade trees on cocoa fields was employed with mapping of individual cocoa farms to determine the shade tree density in the cocoa farming systems. Since retention or removal of the shade trees depends on the internal and external factors interacting together to influence the decision making of the farmers, the farmers were interviewed to know their motion for retention or removal of these trees on the cocoa fields.

The average shade tree density obtained for the traditional cocoa system was 9.55 trees per hectare, and that of hybrid system was 7.24 trees per hectare. Statistically, there was a significant difference between the shade tree density of both systems. The motivational factors for shade trees retention identified in this study were twelve (12) in all the systems. Statistically, there was no significant difference between the all the systems. Six (6) motivational factors were identified for shade trees removal. Of all the motivational factors identified for shade trees removal from the cocoa landscape, only one i.e. over shading was significantly different between the farm types. The results showed insignificant differences for the rest.

Therefore, irrespective of the small difference between the hybrid and traditional farming system the continuous shift from a traditional system of cocoa to hybrid pose a threat to REDD+ implementation in the cocoa landscape since shade tree density decreases in the hybrid cocoa system. However, in improving the carbon stock of the cocoa landscape, both systems should be targeted since cocoa farmers share common motivational factors for shade trees retention.

Keywords: REDD+, Shade trees, Cocoa farms, Traditional, Hybrid, Motivational factors, Cocoa farmers

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AAC	Annual Allowable Cut
DBH	Diameter at Breast Height
GFD	Goaso Forest District
GIS	Geographic Information System
GPS	Global Positioning System
HFZ	High Forest Zone
REDD	Reducing Emissions from Deforestation and forest Degradation
SPOT	Satellites Pour l'Observation de la Terre or Earth-observing Satellites
SPSS	Statistical Package for the Social Sciences
UNFCCC	United Nations Framework Convention on Climate Change
UTM	Universal Traverse Mercator

1. INTRODUCTION

1.1. Background

A disturbed forest cover, whether from climate variability or land- use change affects the functions and degenerates capabilities of a forest to sequester carbon (Pan et al., 2011). Deforestation leads to loss of primary forest and its environmental services worldwide (Flamenco-Sandoval, Martinez Ramos, & Masera, 2007). The main drivers behind the conversion of forest cover are the extension of croplands and cattle pastures, technological advancements, and climatic factors (Salazar, Baldi, Hirota, Syktus, & McAlpine, 2015). With human disturbances in the terrestrial ecosystem, the most affected environmental service is the carbon sink, especially the carbon deposited in the aboveground biomass (Gibbs et al., 2007).

In recent years climate change is recognised as a major environmental issue that has become a topic of considerable debate (Mohanty & Mohanty, 2009). Global climatic change is impacting negatively on several aspects of life including animal mortality and human health (Mohanty & Mohanty, 2009). Addressing this phenomenon requires careful implementations of strategies. One of the ways to address this problem is retaining more carbon in the landscapes. The "United Nations Framework Convention on Climate Change (UNFCCC)" has instituted several measures to curb this environmental problem. The carbon storage in the tropical forest plays a major role in the global carbon cycle. Hence it is considered very important in solving the problem of climate change. Therefore, as a follow-up treaty under Kyoto Protocol, the "Reduced Emissions from Deforestation and Degradation (REDD+)" mechanism was institutionalised by the UNFCCC to decrease emission of carbon dioxide (CO2) ensuing from forest degradation and deforestation (UNEP, 2011). The REDD+ is an incentivised mechanism to reward countries under free-will for protecting the tropical forest and reducing CO2 emissions. Ghana has signed on to this programme like many tropical countries. Ghana, therefore, seeks to implement the REDD+ mechanism through the Nested Approach in the cocoa landscape.

"The "Nested Approach" (NA) is a proposed framework for structuring effective incentive mechanisms for reducing greenhouse gas (GHG) emissions from deforestation and forest degradation (REDD+) at multiple scales" (Conservation International, 2016). Accordingly, this approach ensures compensating REDD+ actions at early development at the subnational implementation of the REDD+ mechanism. Ghana identified cocoa landscape in High Forest Zone (HFZ) for its early stages of REDD+ mechanism implementation (Forestry Commission, 2015). The High Forest Zone is the closed forest in the southern part of Ghana. The HFZ is considered to be a hotspot of biodiversity.

The cocoa cultivation systems in Ghana is considered to be important since the cocoa landscape is noted for its carbon storage. The integration of shade trees in the management of cocoa cultivation contributes the carbon storage of the landscape. The amount of carbon stored in the cocoa landscape in the Eastern Region is between 118.6–223.2 Gg C in Ghana (Mohammed, Robinson, Midmore, & Verhoef, 2016). The government of Ghana wants to increase carbon stock in the cocoa landscape. However, regardless of government policies and interventions, it is the individual farmer who decides on the management of trees density and tree species to be retained or removed from the farms (Oduro, 2016). According to Beedell & Rehman, (2000) introducing any new policy intervention into agriculture field needs a study that combines behavioural and motivational studies. It is required to study this since studying the behavioural and motivational aspect does not only identify the socioeconomic factors influencing the land use change but also to understand the readiness and the capabilities of farmers to be inspired or prevent any farm management that may also influence them (Beedell & Rehman, 2000). In Ghana, studies in the cocoa fields tend to focus on finding shade balancing and identifying shade trees compatibility with the cocoa crops (Asare, 2005). It is, therefore, unclear the main factors that drive the removal or retention of shade trees on cocoa fields. However, clarifying this issue would help in policy planning, aid in designing an agroforestry system and also to secure existing and future carbon stocks in cocoa landscape without impeding the productivity of the cocoa crops.

The cocoa (*Theobroma cacao* Linn.) is one of the world's economic crops which is cultivated in the humid tropics of the Caribbean, South America, Southeast Asia and Africa (Obiri, Bright, McDonald, Anglaaere, & Cobbina, 2007). Although cocoa is considered to be contributing to economic growth of the country, it is also a probable tool for the tropical forest degradation.(Obiri et al., 2007). The cultivation of this cash crop is in the forest regions of Ghana with minimum average rainfall between 1,000-1,500 millimetres per year. The cocoa crop is cultivated as an understorey crop by getting rid of the forest understorey and partially removing the forest canopy (F. Ruf & Zadi, 1998).

The guaranteed price of this crop by the Ghana government has inspired the production of this traditional cash crop since the1940s (Gelens, van Leeuwen, & Hussin, 2010). The crop is cultivated by individual farmers in small holdings of land of about 2 – 5 acres (Hainmueller, Hiscox, & Tampe, 2011), mostly outside forest reserves in the High Forest Zone (HFZ). The cocoa plantations account for about six million ha of the forest zone in West Africa (Wessel & Quist-Wessel, 2015).

There are different types of cocoa management systems. These management systems are partially influenced by the variety of cocoa grown. The main cocoa farming systems in Ghana, are primarily the "shaded" and the "full sun" systems. The shaded system is characterised with patches of forest trees serving as a shade, while, the full sun system is attributed to a total cocoa plantation with little or no shade trees. The latter system of cocoa management reduces carbon storage capacity of the farm considerably (Wade et al., 2010). Previously, in Ghana, the cocoa varieties cultivated were the "Amazons" and "Amelonado". The "Amazons" and "Amelonado" are the traditional varieties which required shade to grow well. These varieties are cultivated under a multi-strata agroforestry system where the non-cocoa trees are kept on the cocoa farm to provide shade. This management system improves the carbon storage capacity of the farm considerably since the non-cocoa trees store carbon. The hybrid variety (Series 2) was introduced in 1984, and it performs better than the older varieties, for example, early fruit bearing, more resistant to diseases and pest and higher yielding capacity (Asante-Poku & Angelucci, 2013). The introduction of the new cocoa variety that is well-thought-out to be "sun loving" requires less shade. The cultivation of this variety led to a cocoa management system that requires little or no shade trees (Obiri et al., 2007). However, between these management systems, different arguments may exist on why shade trees are retained or removed from cocoa farms.

Undoubtedly, the traditional agroforestry cocoa farming is one of the major agricultural activities that can mitigate climate change. This traditional agroforestry is the shaded cocoa farming system, the shade trees on the cocoa farms can enhance carbon sequestration. The indigenous farmers' knowledge in combination with that of ecologists and agronomists is essential to maintain adequate tree density to balance the socio-cultural, "economic and ecological needs" of the farmers (Daghela Bisseleua, Fotio, Yede, Missoup, & Vidal, 2013). Again enticing farmers "from payment for- ecosystem services and certification schemes" can inspire farmers to retain an adequate number of shade trees on farms (Daghela Bisseleua et al., 2013).

The occurrence of the shade trees on the cocoa farm is seen to be playing an essential role in the cocoa ecosystem. However, a large amount of literature indicates farmers involve in hybrid farming system remove these shade trees on cocoa farms. This is done to increase the yield out of the farm (Ruf, 2011). The cocoa farmers in Ghana, however, increase their productivity by expanding their cocoa farms, where primary or secondary forest cover are converted to cocoa farms (Wessel & Quist-Wessel, 2015). This activity affects the forest cover of Ghana and invariably the carbon stock, whilst, good farming practices with fertiliser applications on cocoa farms can increase the productivity of the cocoa farm (Tscharntke et al., 2011), so that other virgin forests can be freed from an expansion of cocoa farms to increase productivity (Alemagi et al., 2015)

1.2. Land Tenure System

In Ghana, land tenure is the main reason for which many farmers decide to choose certain farm management practices (Kotey et al., 1998). The land tenure comprises several laws, rules and commitments that oversee the holdings and ownership rights of land, Kassanga, (1998) as cited by (Damnyag, Saastamoinen, Appiah, & Pappinen, 2012). For instance, there is "the absolute right to control, manage, use and dispose of a piece of land". This is the absolute ownership (the Freehold). The land belonging to a particular person can be leased to another person for a specified "period of time through contractual agreement" (the Leasehold). Also, the statutory allocations where land is assigned for the use of certain legally established body (Damnyag et al., 2012). The land tenure system in Ghana is complicated. The government of Ghana does not conventionally own land. The government acquires land from the chiefs who are customary owners, and compensations are paid to them for developmental purposes. This is practically the statutory allocations. The land ownership is based on kinship and right of use is entrusted to the traditional authority. Family or clan lands are passed on through inheritance (S. Adjei-Nsiah et al., 2004). Chiefs or clan heads can lease farmland to people especially non-indigene for farming purposes. Proceeds of this farm are shared through a shared cropping system called "Abunu" or "Abusa". This is a sharing arrangement between the landowner and the lessee. The "Abunu" literally means share into two parts, and the "Abusa" literally refers to break into three parts. The "abusa" sharing system applies to crops that demand high farm inputs such as fertiliser, herbicides and labour, whereas, the "abunu" applies to crops that demand low farm inputs (Samuel Adjei-Nsiah, Saiedou, Kossou, Sakyi-Dawson, & Kuyper, 2007). With the "Abunu" the proceeds are shared 50% to the landowner and 50% to the lessee, and with the "Abusa" 25% goes to the land owner, and 75% goes to the lessee. Land for cocoa farming is either leased to migrant farmers or sold out to them (S. Adjei-Nsiah et al., 2004).

1.3. Tree Tenure System

Together with land tenure, is the isolated tree tenure in Ghana, which dates back to the colonial era, where ownership privileges to the tree resources were steered by customary law which resided with chiefs (Damnyag et al., 2012). The Forest Services Division, formerly the Forestry Department of Forestry commission of Ghana was engrossed in forest reservation during the colonial era. This tenure right was taken from the chiefs by 1962 and now held in trust by the state for the landowners (Hansen, Lund, & Treue, 2009). The law on ownership of timber trees does not encourage retention of on-farm timber trees. The law states that all natural resources such as naturally regenerated trees are vested in the President on behalf of the people of Ghana as enacted in the Concession Art, No. 124, 1962, section 16(4) (Asare & Anders, 2016). Hence, farmers who nurture naturally regenerated trees on their farms do not directly benefit from the sale of these timber trees. This according to Asare & Anders, (2016), affects the on-farm tree density by decreasing the tree density. The national forest policies on forest management also affect the density of trees on cocoa farms in Ghana. The forest policy requires logging companies to compensate farmers for crop damages during harvest, but, companies do not fully pay this compensation (Kotey et al., 1998). Therefore, farmers with the courage to confront these loggers do not allow logging in their farms.

Therefore, maintaining such valued trees on farms requires the ability to protect these trees from loggers destroying their crops on the farms (Asare & Anders, 2016).

1.4. Shade tree density gradient

The gradient of shade tree density extends from high to low in the cocoa landscape of Ghana. This gradient of shade tree density in cocoa farms are (i) the "rustic cocoa" management, heavily shaded conventionally cocoa farm under thinned forest, (ii) the "planted shade" management, mostly exotic tree species are planted with sporadic residue forest trees and (iii) the "full sun" or the "technified", the mono cocoa plantation without shade as shown in Figures 1-1, 1-2 and 1-3 respectively. (Rice & Greenberg, 2000). However, the shade system being practised in Ghana is between the rustic and the planted shade where some of the native shade trees are removed and replaced with exotic trees. The age of the farm plays an important role in the shade management. All the varieties of cocoa require shade at the early age (1-3 years) of the cocoa seedlings, as reported by Alvin, (1977), as cited in Asare, (2015). More sunlight is allowed to penetrate through the shade trees to the cocoa crops as the cocoa crops mature for the fruition. Hence, physiological development and the ages of the farm determine the density of shade trees. The rustic could be found at the early stage of the farm in Ghana. In situations where trees are not available plantain is used as shade for the early stages of the farm (F. Ruf & Zadi, 1998).

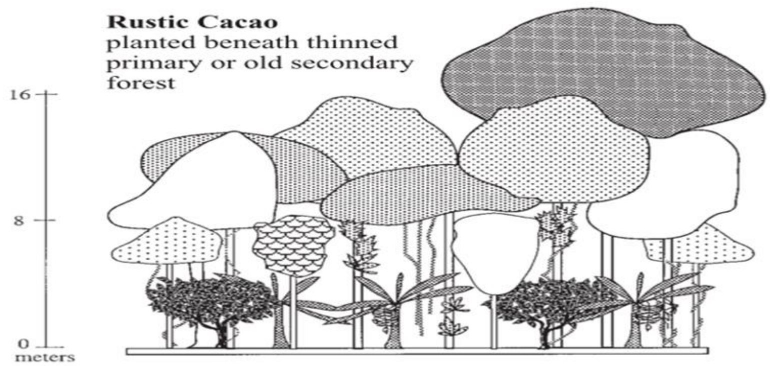

Figure 1-1 A rustic cocoa management system (heavily shaded) (Rice & Greenberg, 2000).

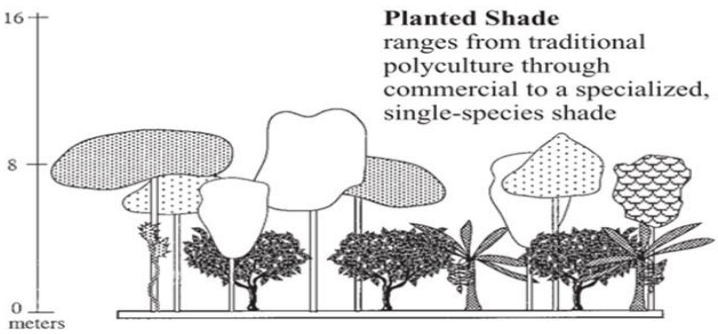

Figure 1-2 A planted shade management system (Rice & Greenberg, 2000).

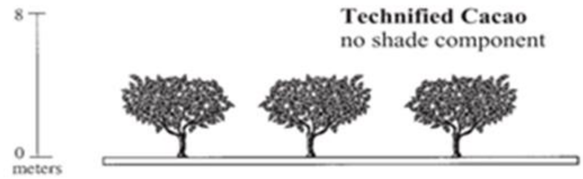

Figure 1-3 No shade management system (Rice & Greenberg, 2000).

1.5. The positive aspect of retaining shade trees

The retention of shade trees on cocoa farms provides certain benefits. For instance, the provision of certain basic needs of the farmers. In Ghana, farmers retain the trees on their farms to be extracted either for timber, firewood, poles as well as traditional or herbal medicine to treat certain illnesses or to benefit from some ecological values. The retention of shade trees in the cocoa agroecosystems is also associated with other socio-cultural benefits. These socio-cultural values of shade trees include the use of certain trees as totems (a symbol of worship). The shade tree on cocoa farms improves the economic livelihood of farmers and government also benefit from the timber species (Asare & Prah, 2011).

The shaded cocoa plantation is an example of an agroforestry system, where shade trees are integrated with cocoa crops. This cocoa agroforestry system in Ghana is characterised by both timber and non-timber trees. There are also, fruit trees of both native and exotic trees being used as shade trees. There are the "economic, ecological, and the sociocultural" values of these trees. (Guo, Hu, Pan, Birdsey, & Fang, 2014). The economic values of shade trees include extraction of timber and charcoal production. The shade trees on cocoa farms especially the merchantable ones, contribute greatly to the timber and logging industries in Ghana (Kotey et al., 1998). The native "timber species such as *Terminalia Superba* (Ofram), *Terminalia ivorensis* (Emere), and *Ceiba pentandra"* for the purposes of providing shade, also help to sustain the timber production in Ghana. This alternative source of timber serves as a buffer to the dwindling forest's resources in Ghana (Boaitey, 2016). In Ghana, the volume of wood demand exceeds the volume of timber harvested from the productive forest reserves. Therefore, more trees are harvested from outside the productive forest reserves to supplement the wood harvested. The Annual Allowable Cut (AAC) is the volume regulating guide for harvesting timber, i.e. the harvested volume of timber within a year. In Ghana, the current AAC is 2 million m^3 (Ministry of Lands and Natural Resources, 2012). The current productive forest reserves alone do not meet this annual allowable cut, hence a supplementary from the off reserves including the farmlands.

The ecological importance of shade trees in cocoa agroforestry cannot be overlooked. They include habitat provision for animal species, provision of corridors for animals between interrupted areas, and conservation of plant species genetic resources (Jose, 2009). Apart from biodiversity, there are other ecological services that are attained by maintaining and managing the shade trees in the cocoa agroecosystem. These include soil erosion control, watershed protection, windbreak, etc. Beer et al., (1998) identified two major physiological benefits of shade trees in cocoa farms; 1. enhancing the microclimatic and site condition through (i) balancing extreme of soil and air temperatures, (ii) lessening of wind speeds, (iii) humidity and soil moisture availability buffering, and (iv) maintaining soil fertility also erosion ; and 2. regulating the quality and quantity of sunlight transmission.

The cocoa farmers in Ghana are also motivated to retain these trees on their farms because of certain factors. Oduro, (2016), identified six (6) major motivational factors influencing farmers to engage in tree planting and maintaining trees on the farms. These factors were (i) the financial benefits to be accrued from the sale of the trees. The farmers involve in tree planting believe to receive future income from the sale of these trees. (ii) awareness of farmers about current environmental issues, some of the farmers acknowledge the issue of climate change and hence, engage in tree plant to mitigate the problem. (iii) security for future for his/her children, some of the farmers also see the planting of trees on their farms as a form of investment, where their children can benefit from in the future. (iv) tree ownership, the ownership of trees also encourages farmers to engage in on-farm tree planting so that this tree can be used personally for whatever purpose. (v) tree planting schemes, this is where farmers are motivated to plant trees due to campaign for tree planting, (vi) provision of farm inputs as incentives, in situations where farmers are provided with some farm input also encourage them to engage in on-farm tree planting. Depending on the type of shade trees retained on farmland, the farmer's income may increase as a result of an increase in productivity on the same plot of land (Hoogendjik, 2012). Besides, increase in cocoa production in an intensified farming system (mono-cocoa cropping and chemical applications), the inclusion of non-cocoa trees, also increases the revenue of farmers by selling Non-Timber Forest Products (NTFPs) collected from these trees (Alemagi et al., 2015).

1.6. Negative Aspect of Retaining Shade Trees

The benefits of trees in agroecosystems are not limited to the locality where they are found, but their importance extends beyond the vicinity to regional and even to global. Globally, trees are useful for its role in climate change mitigation. In spite of this seeming importance of trees in the agroecosystem, retaining and maintaining such trees on farms come with its challenges. Tree tenure, land tenure, crop damage during timber harvest, and weak law enforcement were some the barriers impeding the retention of trees in an agroecosystem in Ghana (Oduro, 2016). It is believed that some of the native trees are not compatible with cocoa crops (Asare, 2005). Some of the shade trees in the cocoa agroecosystem possess certain traits and characteristics that are not favourable to the cocoa farms. For instance, the self-pruning trait of shade trees such as *Ceiba petandra* which damage the cocoa crops during such branch dropping (John Beer, 1987). Some of the trees promote the conditions for cocoa disease such as Black Pod Disease (*phythphora palmivora*). As a result of non-cocoa trees, the conditions for fungal diseases development is promoted with limited aeration and increased humidity in the cocoa farms (John Beer, 1987). Therefore, the cocoa farmers perceive some of these non-cocoa trees to be serving as substitute hosts for pests and diseases. Some of these shade trees are also deciduous in nature, and the leaves are shed seasonally. The defoliation of these shade trees either as a result of seasonal changes or insect infestation impacts on the shade adapted cocoa crops and caused dieback as a result of shock (John Beer, 1987). The cocoa crops under shade trees also increase labour cost of the farm. The increase in the labour cost is as a result of the cocoa plants growing very tall and harvesting becoming difficult (John Beer, 1987). There is also the competition of nutrient and water with the cocoa crops (J Beer et al., 1998). This competition reduces the availability of moisture and nutrient to the cocoa crops, hence, reducing the yield of the farm. There is a crusade to eliminate a list of non-cocoa trees species that are perceived by farmers to be incompatible with cocoa crops. For instance, the *Cola nitida, Ceiba pentandra*, and *Triplochiton scleroxylon* are common on the list. A particular example is the release of some powdery substance which is believed to be fungal spore, and it is considered to be harmful to cocoa crop (Asare, 2005) The biodiversity of the cocoa farm is negatively affected, insects such as spider webs and wasp nest are reduced considerably with an increase in exotic species is used as shade trees (Daghela Bisseleua et al., 2013). Because the removal of the shade trees is detrimental to the ecosystem services, Tscharntke et al., (2011) suggested that as a means sustainable management, it is realistic to maintain a high shade tree density on young cocoa plantations and gradually prune the shade trees as the cocoa crops develop instead of removing or killing them totally.

When the new hybrid variety was introduced, farmers are shifting from the traditional to this new hybrid variety system. However, some of the farmers have not completely removed shade trees on the hybrid cocoa farm as expected. Both systems of cocoa farming are retaining shade trees with a variation of shade tree density. Meanwhile, studies revealed that the non-shade hybrid cocoa farming system yields as much as twice the yield of the shaded traditional and shaded hybrid (Obiri et al., 2007). The management of density of non-cocoa trees otherwise called shade trees on cocoa farms is affected by some of these factors.

1.7. The Cocoa Farmer's Motivation for Shade Trees

On-farm trees are managed by farmers for timber, fruits, poles, shade for crops, soil fertility improvement and environmental protection (Oduro, 2016). According to Anglaaere et al., (2011), retaining a particular shade tree on the cocoa field depends on the preferences and the usefulness of that shade tree to the farmer. The motivational factors influencing farmers are either the farmer's inherent desire or external factors to retain or remove the shade trees. In Ghana, cocoa farmers integrate fruit trees mostly non-native on the cocoa farms. However, introducing exotic tree species as shade trees come with its problems. Some of the exotic trees planted in the cocoa field include *Tectona grandis* (Teak) and fruit trees such as mango (*Mangifera indica*) and avocado pear (*Persea americana)*. Some of these integrated shade trees serve as an alternative source of income to the farmers. The farmers sell fruits from these shade trees to supplement their income. For instance, the sale of "prekese" (*Tetrapleura tetraptera*) a local spice which is very popular with Ghanaians especially the Akans. A well-designed agroforestry system of a cocoa farm do not only enhance plants and animals diversity and carbon sequestration but increase income as well (Rajab, Leuschner, Barus, Tjoa, & Hertel, 2016).

Farmer's willingness to part take in conservation management is affected by knowledge or information available to them and the incentives to be accrued from the conservation management (Beedell & Rehman, 2000). According to Denkyirah et al., (2016), the level of education, years of experience in cocoa farming, access to extension services were identified as some of the factors affecting farmers' decision to apply pesticide on cocoa farms in Ghana. Therefore, knowledge and experience play a crucial role in cocoa farming in Ghana. The cocoa farmers may be influenced by these factors to retain shade trees on cocoa farms.

The actions and inactions of farmers, fringe communities of forest reserves and landholding chiefs impacts on the management of forest in Ghana (Kotey et al., 1998). This translate to the management of trees on farms as well. In some of the towns, the community's chiefs abhor the illegalities of chainsaw activities. Hence, strong community heads protect shade trees on cocoa farms by adhering strictly to communal regulations. Therefore, shade trees retention or removal rest on the farmer and the community as a whole. The shade trees in cocoa farms are not in any particular configuration. The shade trees are either occurring on the boundary of the cocoa farms or chaotically spotted on the farm. Although there are certain wild fruit trees that are retained, there are also planted fruit trees mostly on the boundary for distinguishing between farms.

Again, farmers may also be encouraged to remove shade trees from their farms due to the tree tenure system in Ghana, where, farmers do not benefit directly from the sale of the shade trees they nurtured on their farms. Evading crop damage by these shade trees during harvest may also influence the farmer to remove such trees before planting their crops. Farmers are also entitled to compensation from loggers during the harvest of the merchantable economic shade trees from their farms. However, due to poor law enforcement, loggers refuse to pay sufficient compensation to farmers (Oduro, 2016). This motivates the farmers to chard or girdles the shade trees to death. Farmers in the quest to avoid crop damage by loggers also retain few needed shade trees which are merchantable (Asare, 2016). Asare, (2015) again posited that a major challenge of having shaded cocoa farm is that shade trees reduce the productivity of the cocoa crop. All these influences the shade tree density of the cocoa farm. The cocoa farmers compare the benefits and drawbacks of these shade trees on their cocoa fields and then decide to retain the shade trees or remove them.

The farm sizes and the density of on-farm trees are affected by gender. The shade tree density is attributed to the size of farm and gender of farm owner (Asare & Anders, 2016). They argued that males turn to have bigger farms compared to the females since clearing forest is an activity reserved for men. Therefore is the responsibility a man clear the forest and give a portion to the wife (female). The number of shade tree are high in large farms, and again men are placed in a position to confront illegal loggers. On the other hand, three factors were also identified as factors impeding farmers from participating in on-farm trees planting in Ghana. The factors impeding on-farm tree planting as identified by Asare, (2016) includes the tree tenure system in Ghana, crop damage by loggers during harvest and inadequate compensation from loggers. These factors may also encourage cocoa farmers to remove shade tree from their cocoa farms.

1.8. Conceptual Diagram

The cocoa farmers reduce the shade tree density of the cocoa farm because of biophysical or socioeconomic factors. Most of the cocoa farms in Ghana are low in shade tree stock due to their removal to pave the way for more yield or for other socio-economical needs. Under the business as usual, farmers usually remove shade trees gradually from the traditional system. This reduces the carbon stock of the farm making the traditional system a low carbon stock farm. The farmers then convert the low carbon stock of the traditional to the hybrid system. Under the REDD+ implementation mechanism, it is expected that the carbon stock of the cocoa farm is increased for carbon monitoring purposes. For this reason, it was anticipated that farmers retain a higher stock of shade trees. However, the traditional cocoa systems are transiting to the low-carbon hybrid system as indicated by the red line in Figure 1-4 below. It summarises, the biophysical and socioeconomic factors influencing retention or removal of shade trees on cocoa farms.

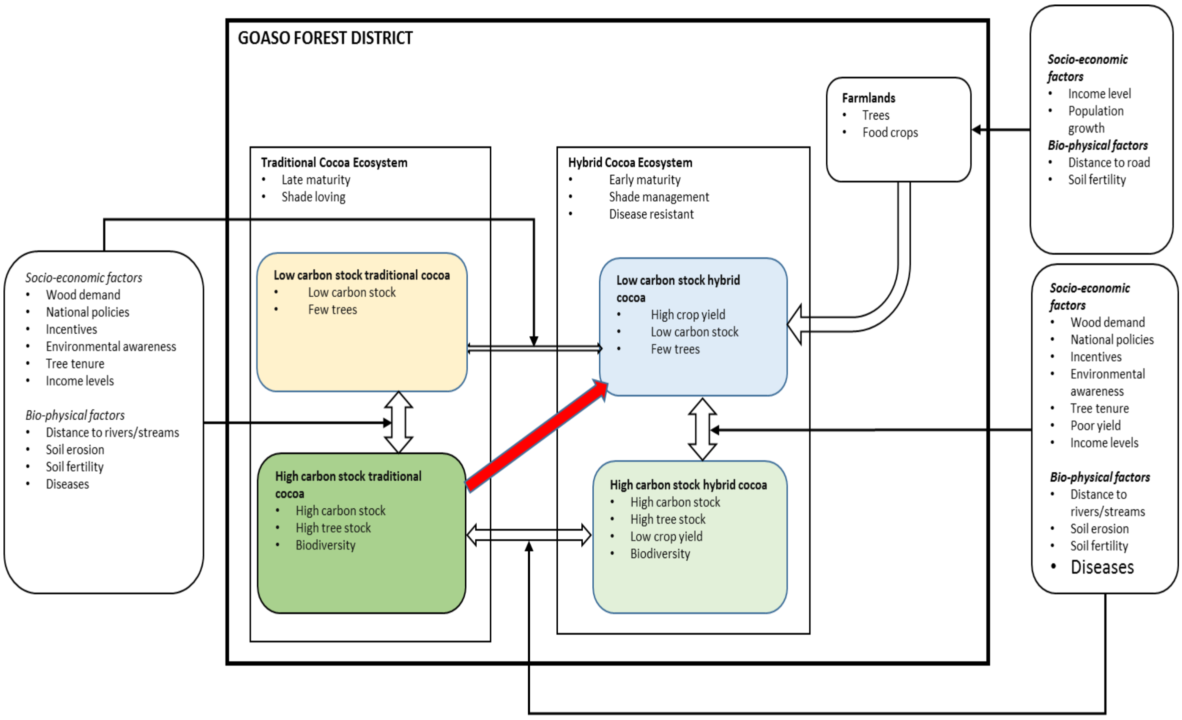

Figure 1-4 Conceptual diagram

1.9. Research Problem

A nested approach is adopted in Ghana for REDD+ implementation in phases beginning with High Forest Zone (HFZ) and then to be upscaled to cover other ecological zones. Under this approach, Ghana seeks to implement REDD+ through a land use system that incorporates tree crops with a substantial shade canopy of forest trees. (Forestry Commission, 2015). For instance, the Cocoa ecosystem has been identified to store carbon (Mohammed, Robinson, Midmore, & Verhoef, 2016), Owing to carbon storage capacity of the cocoa ecosystem, Ghana recognises the cocoa landscape as a potential landscape for the REDD+ mechanism implementation. This approach is expected to sufficiently decrease emissions driven by cocoa farming, in a manner that will safeguard the future of forests in Ghana (Forestry Commission, 2015). Therefore, maintaining a significant number of non-cocoa trees in the cocoa landscape for storing carbon or receiving benefits from implementing REDD+ is essential.

1.10. Research objectives

1.10.1. General Objective

To examine the motivational factors to remove or retain shade trees on cocoa farms for REDD+ implementation in the Goaso Forest District of Ghana.

1.10.2. Specific Objectives

1. To identify the main factors that determine the density of shade trees on cocoa farms in Goaso?
2. To identify motivational factors influencing retention of shade trees on hybrid cocoa farms and traditional farms.
3. To identify the motivational factors influencing the removal of shade trees on traditional cocoa farms in Goaso Forest District.

1.11. Research Questions

1. Are there differences in shade tree density between hybrid and traditional cocoa farms?
2. Are there differences between the motivational factors to retain shade trees between farmers of hybrid and traditional cocoa varieties?
3. Are there differences between the motivational factors to remove the shade trees between farmers of hybrid and traditional varieties?

1.12. Hypothesis

I. There is a significant difference in the density of shade trees between farmers with traditional and hybrid cocoa varieties.

II. There is a significant difference in the motivational factors to retain shade trees between farmers of traditional and hybrid cocoa varieties.

III. There is a significant difference in the motivational factors to remove shade trees between farmers of traditional and hybrid cocoa varieties.

2. MATERIALS AND METHODS

This chapter covers the main activities in the study. It accounts how data and where data was collected, including the study area description and sampling strategy. It further describes how the data from the field together with satellite data were processed and analysed as indicated in the flowchart in Figure 3-1.

2.1. The Flowchart

The research methodology and activities are summarised and depicted in Figure 3-1 below.

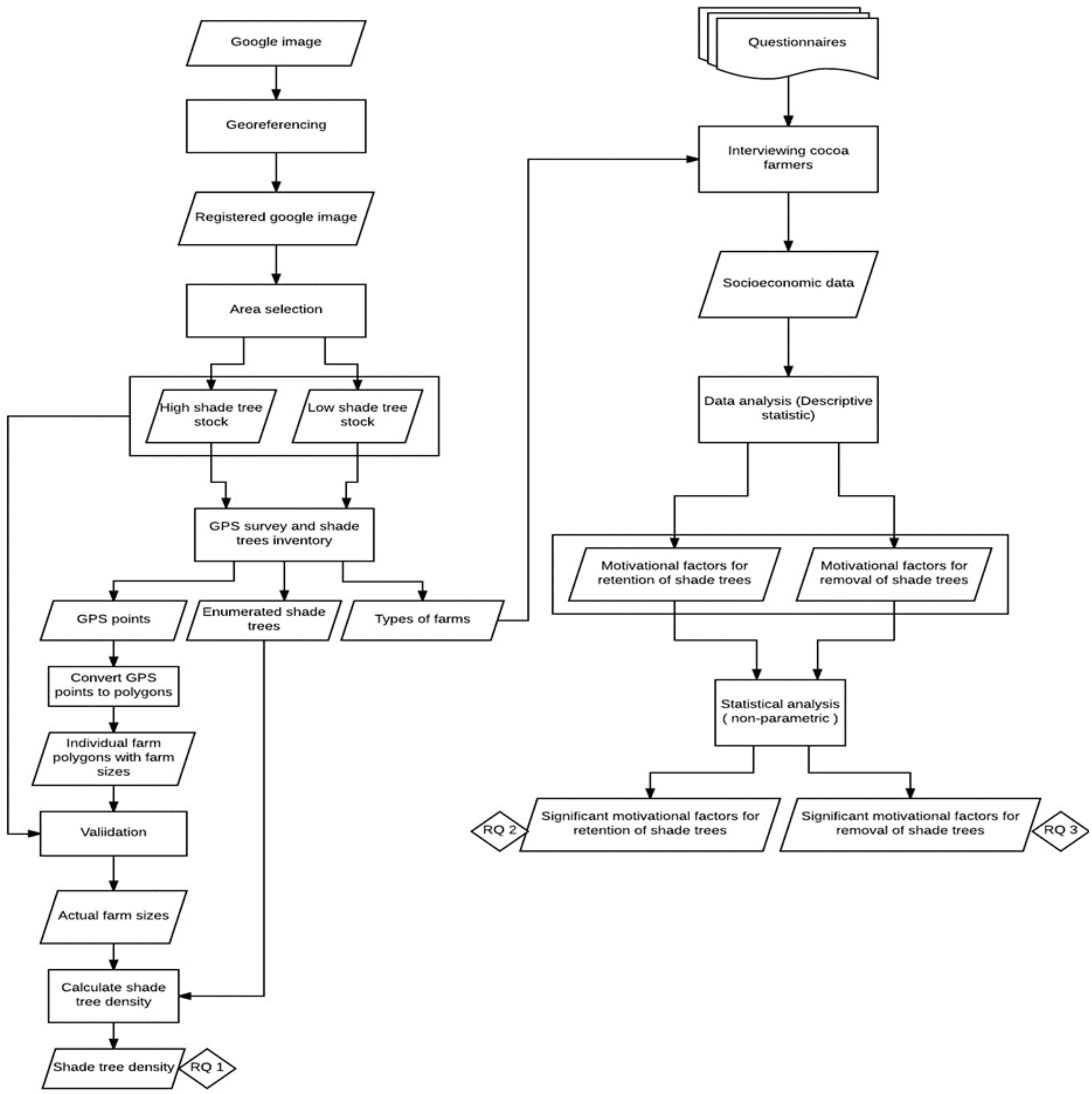

Figure 2-1 A flowchart showing steps and processes of the study

2.2. Study Area

The study area was the Goaso Forest District (GFD) in the Brong Ahafo Region of Ghana, West Africa. Geographically it is located between latitudes 6°47'48" N and 7°06'44" and Longitude 2°38'45"W and 2°17'53"W. The area is shown in figure 3.5. The area is noted for extensive cocoa cultivation, and there are many cocoa farmers in the district, with different kind of shade managing systems. It was expected that there was also variability in shade tree densities and motivations on why shade trees were retained or removed from these cocoa farms. The area coverage is about of 2,187.5 km2 of which 27.11% is permanently reserved forest estate. The study covered four individual farming communities in the district. The climate of Goaso is a humid tropical with annual rainfall between 1250 – 1750 mm. It has a bi-modal rainfall with the first period being April – July and the second period being September – October (Gelens et al., 2010).

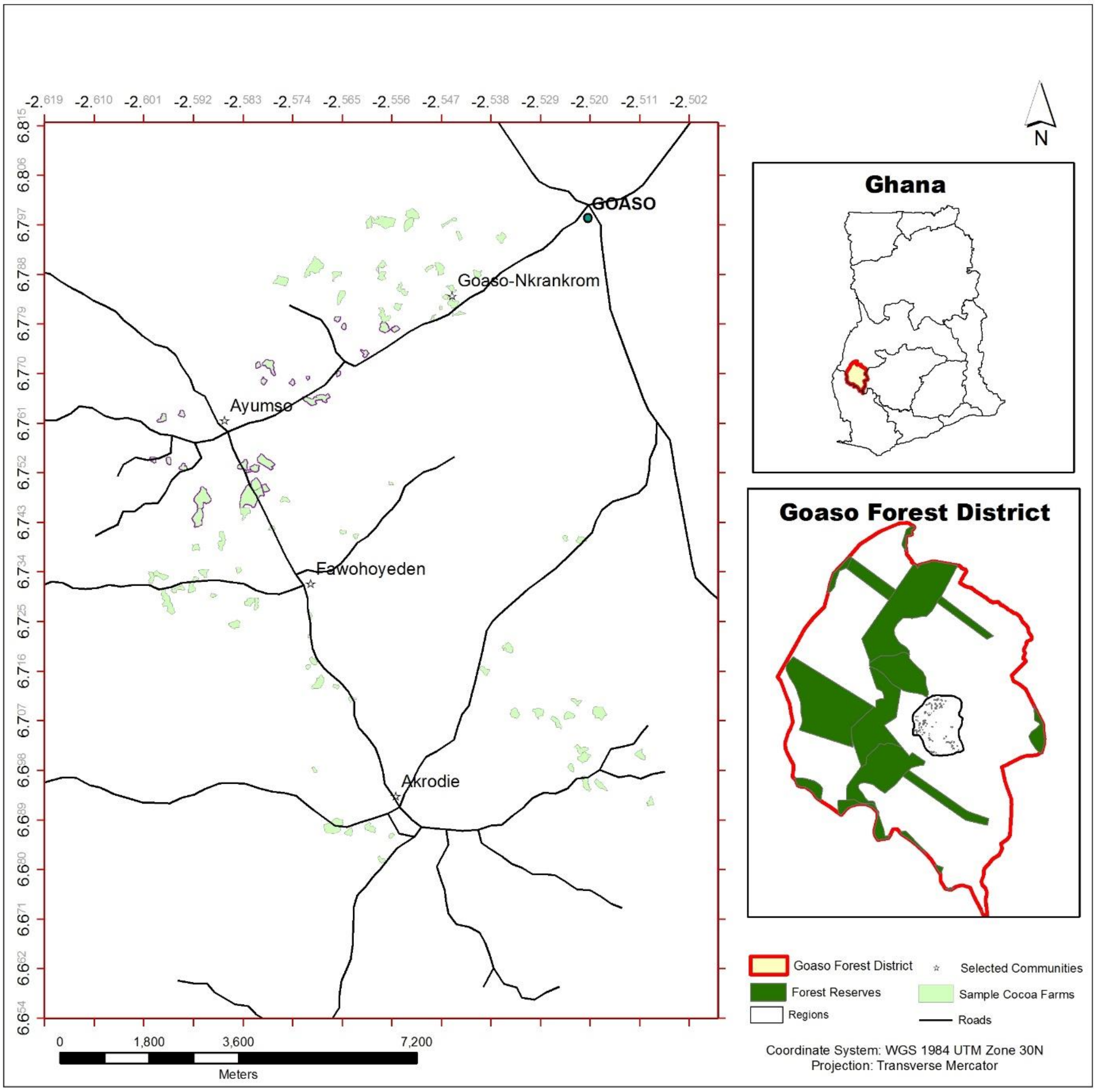

Figure 2-2 A map showing the study area

2.3. Vegetation Cover

The area is in the High Forest Zone (HFZ) of Ghana with forest type being the moist semi-deciduous forest(Kotey et al., 1998). Apart from permanent forest estate, the land cover is mainly a mosaic of cocoa farms, fallow lands, patches of secondary forest and other agriculture fields. The other agricultural lands consist of perennial crops like oil palm plantations and citrus fruits and subsistent annual crop farmlands such as plantains, maize, coco-yams, etc.

2.4. Socio-economic profile

About 70% of the inhabitants of Goaso Forest District are into farming activities which are the main economic activities in the district. Apart from the agricultural activities, others are into trading (14%,), servicing (10%) and timber logging (6%) (Gelens et al., 2010). Farmers of the Goaso Forest District are into several farming activities of which cocoa farming is the primary farming activity which doubles as a significant economic activity for the country. These farmers are entitled to the services of extension officers, who visit their farms to advise them on new policies and techniques in farming. According to the Agricultural Extension service centre in Goaso Forest District in the Brong Ahafo Region, the ratio of extension officers to farmers in the district is 1:44. This is inadequate according to the agricultural extension office in the study area.

2.5. Data, Software and Equipment

The research was carried out with primary data mainly from field observations, measurements, interviews and secondary data such as images from google earth.

2.5.1. Data

Google image of SPOT 5 which was at a scale of 2.5 meters, captured on 22nd January 2012 was used for this work. A high-resolution image, where individual trees could be seen on the image. This image was used to select the sample farms. The cocoa farms observations and farm sizes were acquired from the field. A Global Positioning System (GPS) receiver was used to traverse the individual farm boundaries of farms to get the farm area in hectares, and all the non-cocoa trees were counted and recorded in a separate data sheet.

2.5.2. Software, Tools, and Equipment

The field instruments used for this research consisted of a GPS, tablet (with locus map App) for direction-finding. ArcMap 10.4.1 was used for visual delineation and other GIS operations such as tree density map and visualisation. For statistical analysis, SPSS and Microsoft Excel 2016 was used. For the purpose of this study Table 2-1 below summarises the instrument that was used. The software packages used for this research are also tabulated in Table 3-2 below.

Table 2-1 A table showing tools and equipment used

No.	Instrument	Purpose
1	Tablet, GPS	Geospatial location of sampling farm and traversing the boundary of the farm
2	Clipboard	Hold data sheet
3	Datasheet	Recording data
4	Questionnaire	Interviewing cocoa farmers

2.6. Sampling Design

It was assumed that basically cocoa farms with a high density of shade trees are the traditional cocoa system and the farms with a low density of trees is the hybrid system. Hence, the density of shade trees on the farm was the determining factor for the selection of farmers for the socioeconomic survey. This is a purposive sampling design which includes farmers with a different gradient in tree densities on their farms. The information on the type of variety was inquired from the farmers who were interviewed. This approach was made to inquire from respondents the information with regards to motivation for keeping or removing the trees on their cocoa farms.

2.7. Pre-field work

A detail work plan, specifying all the activities to be carried out on the field was developed. This detailed plan included the number of farmers to be interviewed, the location of the selected communities and the samples farms were also determined. A semi-structured questionnaire was designed. This is further detailed in section 3.7.2. This was pre-tested by interviewing colleagues. The questionnaire is found in Appendix 1. Also, data sheet for field inventory, data collection and observations to be made in the field was developed. This data sheet contained different sections. There was a section for farm number, to be able to link that particular farm to the owner of the farm. A section for recording the starting point of GPS waypoint and ending point of the GPS waypoint and the section for the number of shade trees counted on the farm. (Appendix 2)

2.7.1. Image processing and sampling design

A Google image (SPOT 5 at a scale of 2.5 meters acquired on 22nd January 2012) was zoom into pixel size of 1.3cm of RGB composite. Place marks were put on the scene to be downloaded for easy geo-referencing and co-registration. A couple of such scenes covering the four communities for the selected area as the study area were downloaded from google earth. The images were georeferenced and co-registered with the UTM 30N projection, WGS 1984 spheroid datum using ArcGIS 10.4.1 software. The images were then mosaicked to form the study area. It was then delineated into the traditional cocoa farm and the hybrid cocoa farms based on visual interpretation. The assumed traditional farms were identified with red outlined polygons, and the supposed hybrid farms were identified with green outlined polygons (Appendix 3).

2.8. Field work

The field work was primarily interviewing cocoa farmers as well as visiting their cocoa farms to measure the farm area and count the shade trees to determine shade trees per hectare (shade tree density) and the species.

2.8.1. Data collection on the farm

A total of hundred farms were visited, twenty-five from each of the four selected communities, Goaso-Nkrankrom, Ayumso, Fawohoyeden, and Akrodie. In each of these communities, either the farm owner or the caretaker of the farm was interviewed. The preselected cocoa fields were navigated to the exact location with mobile GPS and the digital map stored in "Locus app" on Samsung tablet. Some of the preselected areas which were assumed to be cocoa farm from the google image were not cocoa farms. In such situations, adjacent nearby cocoa farms were captured. All the sample farms were visited to determine sizes of the farms instead of relying on the guessed estimations from the farmers. The non-cocoa trees with Diameter at Breast Height (DBH) above 10cm were counted and recorded. The sizes of farms were obtained to determine the shade tree density per unit area. Asare & Anders, (2016) employed such method to determine tree density.

2.8.2. Socio-economic Survey

Two research assistants were engaged in administering a semi-structured questionnaire, both were BSc holders and well versed in the knowledge, culture, and geography of the study area. Both traditional and hybrid cocoa farmers being farm owners and caretakers were interviewed. The research period (26th September to 18th October) which coincided with the harvesting season of cocoa in the study area, therefore, most farmers were met on the selected farms. Mostly, interviews were conducted on the farm or at the home of farmers, since most farmers have their cottages on or near their farms. The interviews were conducted in 'Akan' dialect, a dominant native dialect of the area. Biases were minimised by avoiding leading questions to the farmers. Questions posed focused on socioeconomic factors, demography of farmers' educational background, motivational factors for retaining shade trees and motivational factors for removing shade trees on cocoa farms. The semi-structured questionnaire used for this survey was segmented into four (4) sections. The sections sought to find out, the background of the farmer, ownership, type of farm, motivational factors to retain shade trees and the motivational factors for removing shade tree on cocoa farms respectively. The first section inquired of the age of the farmers, the gender, the educational level, the number of households, marital status and whether the farmer was indigenous or migrant. The second sought to question the mode of acquisition of farmland, whether the farmland was acquired through outright purchase, or leased. If leased, then what was the lease agreement? This section also dealt with the type cocoa field the farmer was practising. The third section was basically about the motivational factors for retaining shade trees on the cocoa field. This section started with an open question, asking the farmer for possible reasons why a farmer would like to keep trees on the farm, without any further clues from the interviewer. Secondly, a number of factors were mentioned to the farmer, and it was asked to what extent these factors were influencing the farmer's decision to retain trees on the farm. The predetermined motivational factors included biodiversity, climate change, soil quality, investment, tree planting scheme, provision of chemicals and provision of tree seedlings. The farmers were then asked to scale these motivational factors using Likert-scale, on a scale of 0 – 3, where 3 is the most important, 2 is fairly important, 1 is important and 0 being not important to the farmer. The farmers were then asked to rank three of these motivational factors in order of importance. The fourth section sought to inquire from the farmers the motivational factors for removing shade trees from their cocoa fields. This section also had predetermined motivational factors which included the destruction of cocoa crops during logging by loggers, non-payment of compensation by logging companies and not benefiting from the sale of timber shade trees to loggers. Also, additional motivational factors that were mentioned by the farmers were added to the predetermined factors, and farmers scaled and ranked as it was done in the third section.

2.9. Statistical Analysis

Both descriptive and non-parametric comparative statistical techniques were employed in this study. Descriptive statistics were based on frequencies and aggregated scores from the respondents of all the four communities. Kruskal-Wallis test was used to test whether there were significant differences between the three groups of the farm systems identified, the hybrid, the traditional and mixed farms. The test of significant difference within two groups of farm system was done using Mann- Whitney U test. Farmers ranked the importance of these motivational factors. Among the three groups, the mean values of these were compared. Since the data was not normally distributed it did not follow to the assumptions of parametric tests and these could not be used (McDonald, 2009). Hence the use of non-parametric tests (Kruskal-Wallis test and Mann- Whitney U test). These tests assisted in determining whether there were differences in the mean of the Likert-scaled data by the cocoa farmers. Analysis of the shade tree density differences was performed on the types of farms, i.e. the hybrid, the traditional and the mixed farms. The shade tree density differences of gender, type of farmers (i.e. indigenous or migrant), the ages of the farms, and the perimeter of the farms were also analysed. These were performed to ascertain whether the farm perimeter, the farm ages, gender, and type of farmers had an influence on shade tree density of the farms.

3. RESULTS

This is the chapter that details the results. The results section is organised into three sections. The first section gives an overview of the distribution of the data across farm types and also entails an initial outlier analysis. The second section presents a statistical analysis of the differences in tree densities between farm types. The third section describes differences in motivational factor between different farmers, and what the main reasons for these differences are.

3.1. Field Data

In the sample, 50 % of the interviewed farmers were of local origin, and the other 50% were migrants (Figure 3-1A). The majority of interviewed people were males. The female farmers interviewed were 44% (35% Figure 3-1B). There were three types of cocoa systems identified; the traditional cocoa field, the hybrid cocoa field and the mixture of both traditional and hybrid cocoa field which were primarily undergoing a transition from traditional to hybrid. A cocoa farm was considered a particular type of farm if it has above 95% of particular cocoa variety. The cocoa farmers were knowledgeable enough to tell even the number of cocoa trees that were of different variety in situations where they mixed the varieties. This ability made it possible to determine whether a farm was mixed or otherwise. Most of the interviewed farmers were into a hybrid system of cocoa farming. Only 16% of respondents were into the traditional system of cocoa farming (Figure 3-2 A). The preselection of cocoa field did not consider any factor except shade tree stock of the farms. However, males and females were fairly represented.

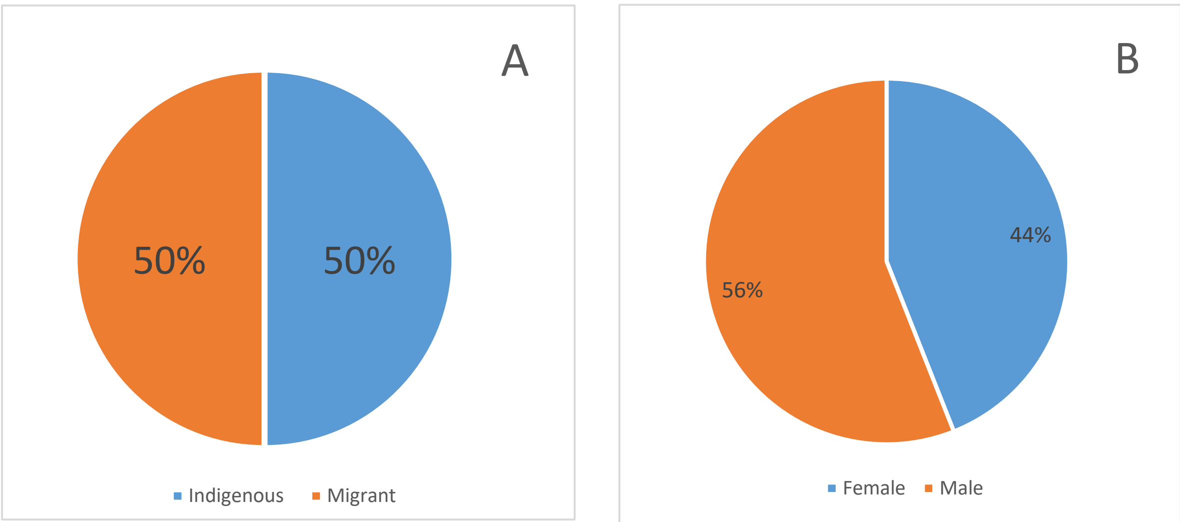

Figure 3-1 'A' - distribution origin and 'B' gender distribution of respondents

The cocoa farms were presented to current owner either as a gift or inherited i.e. passed on to the present owner as a result of the death of the actual owner, or the farmland was purchased directly. The number of the respondents found to have acquired the farmlands as a result of leasing were 35%. The lease arrangement is contracted on the shared cropping system. (Adjei-Nsiah et al., 2004). 34% of the respondents inherited the farmlands while 19% of the farmlands were gifts. Only 12% of farmers acquired the farmland through outright purchase. A high percentage of farmers acquired farmlands through lease and inheritance (Figure 3-2 'B').

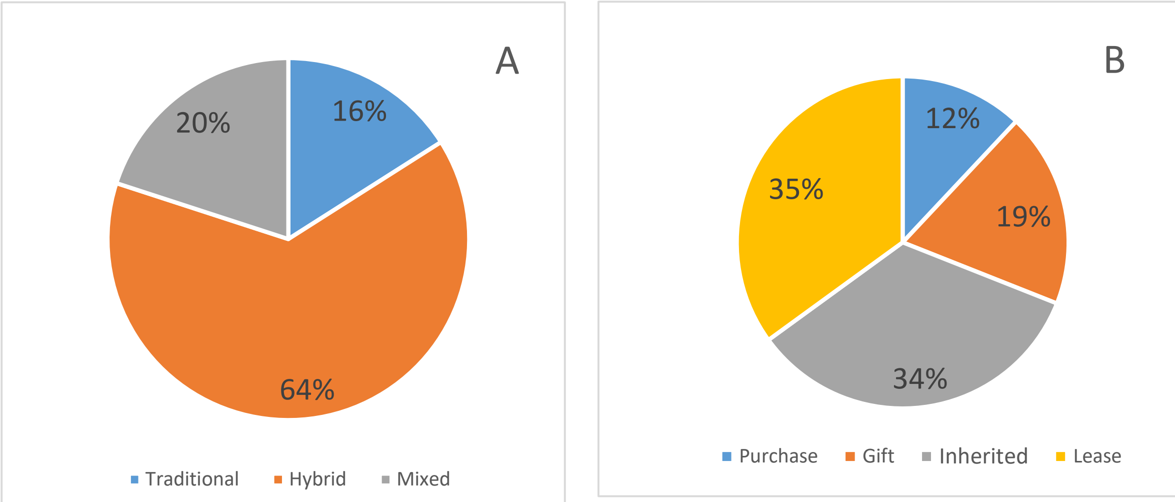

Figure 3-2 'A' percentage farming systems and 'B' distribution of mode of land acquisition

3.1.1. Farm Sizes

The range of farm sizes was between 0.2 and 12 hectares. Hybrid cocoa field recorded the minimum and maximum farms sizes. There were only marginal differences in farm sizes between the different types of farms (Figure 3-3)

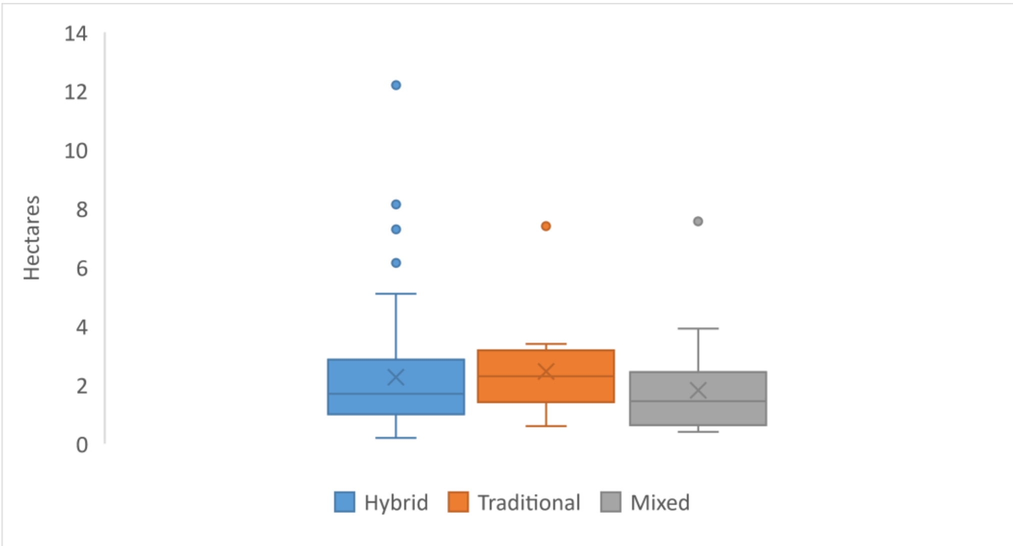

Figure 3-3 A box plot showing farm sizes of respondents

3.2. Density of Shade Trees

After analysing the shade tree density differences between the types of farming systems, the farm perimeter, the farm ages, gender, and type of farmers, some showed significant differences and others did not.

3.2.1. Tree Density and Type of Farming Systems

It was found that the density of shade trees in the various cocoa farming systems; the mixed cocoa system had the highest average of shade tree density of 11.42 shade trees per hectare, followed by the traditional with 9.55 and the hybrid cocoa system with 7.24. There were a lot of variation around the mean of the cocoa field which is a mixture of traditional and hybrid cocoa (Figure 3-4).

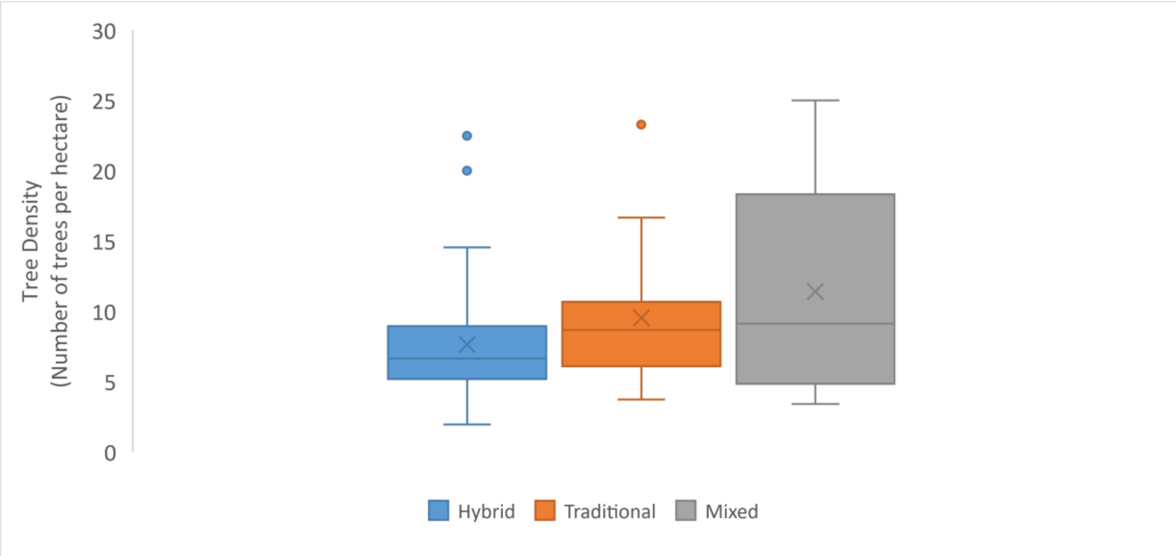

Figure 3-4 A box of shade tree density of the different systems

There was a statistical difference in shade tree densities between the different farm types (Kruskal-Wallis, P=0.03) The significance of the test prompted a further test using Mann-Whitney U's test to compare between 2 groups. A Mann-Whitney U's test between shade tree density of hybrid cocoa system and the traditional cocoa system was significant (P= 0.037). Between the mean shade tree densities of hybrid cocoa systems and mixed cocoa systems also a significant (P = 0.04). However, between the means of shade tree density of traditional and mixed cocoa systems was no significant difference (P = 0.787).

3.2.2. Tree Density and Gender

The shade tree density of cocoa farms was affected by gender. Males had a higher density of shade trees on their cocoa farms compared to female owners. Figure 4.5 shows slight differences in the mean of the shade tree density between male and female farmers in the study area. However, there was no insignificant (P = 0.129).

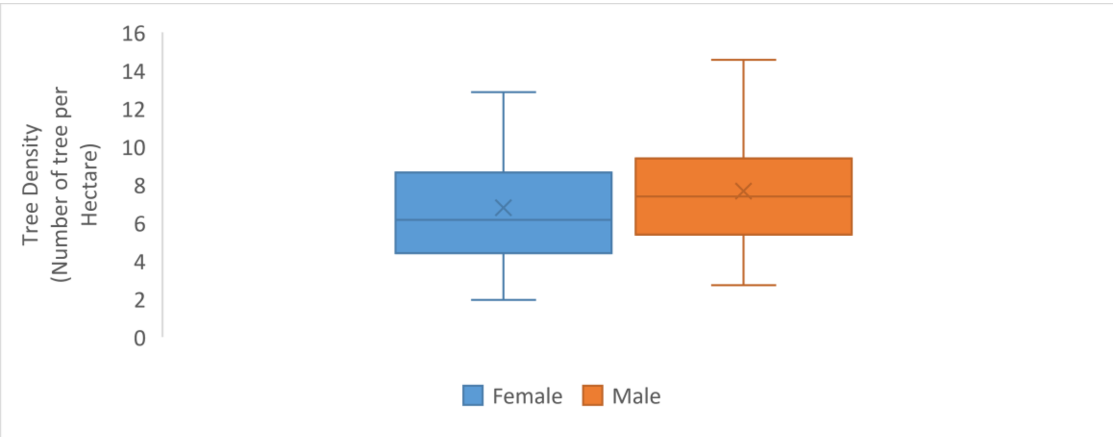

Figure 3-5 A box plot shade tree density of gender of respondents

3.2.3. Tree Density and Type of Farmer (Indigenous and Migrant)

The differences in mean of shade tree density per each type of cocoa system between indigenous and migrant farmers are shown in Figures 4-6, 4-7 and 4-8; hybrid, traditional and mixed cocoa systems respectively. The shade tree density of the cocoa hybrid system varied slightly between the indigenous and the migrant farmers. The indigenous hybrid cocoa farmer had an average shade tree density of 7.06 trees per hectare and the migrant hybrid cocoa farmers 6.49 shade trees per hectare. The average shade tree density of indigenous and migrant traditional cocoa farmers were 14.61 shade trees per hectare and 7.26 shade trees per hectare respectively. The average shade tree density of indigenous and migrant mixed cocoa farmers were 10.77 shade trees per hectare and 12.08 shade trees per hectare respectively.

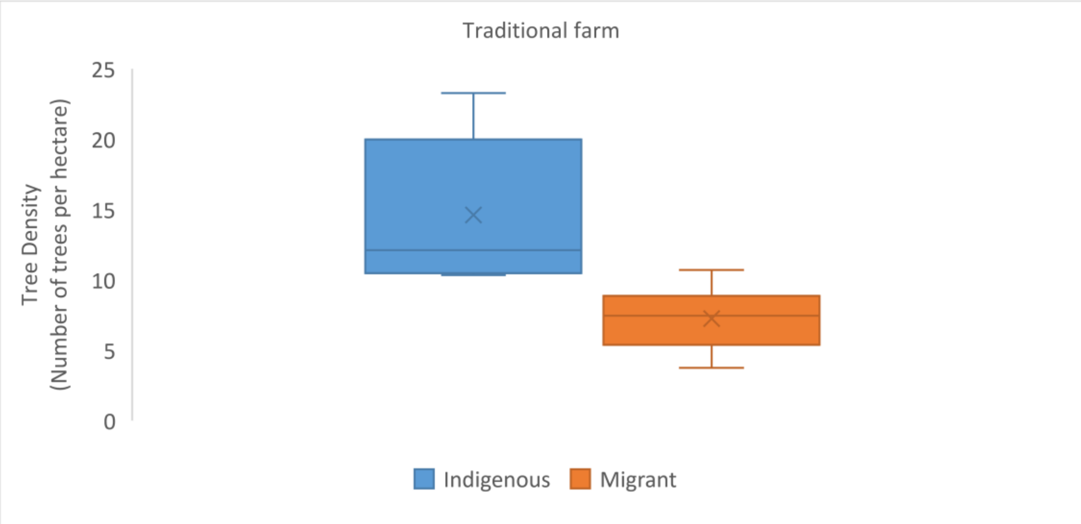

Figure 3-6 Difference between shade tree density of indigenous and migrant farmers involve in the traditional system

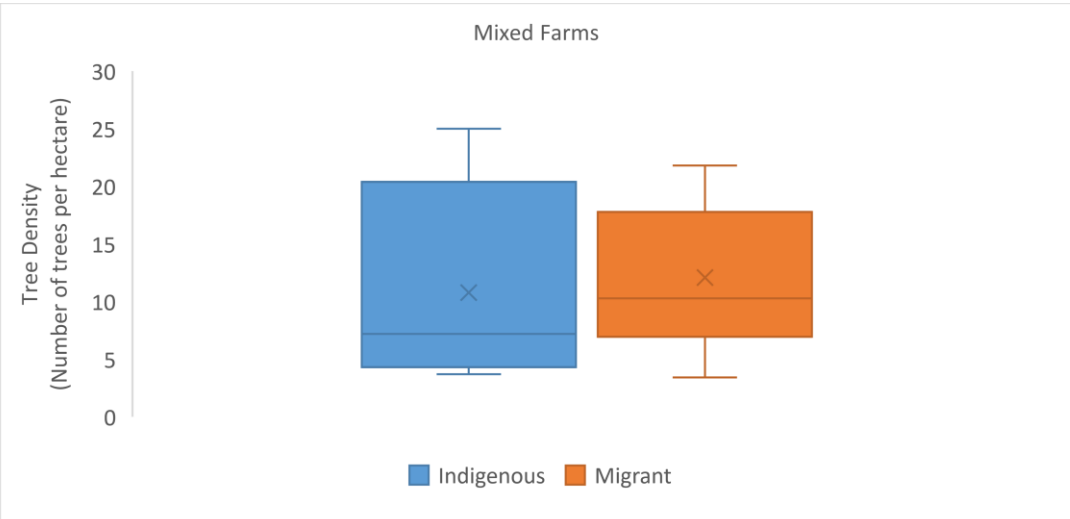

Figure 3-7 Difference between shade tree density of indigenous and migrant farmers involve in the mixed system

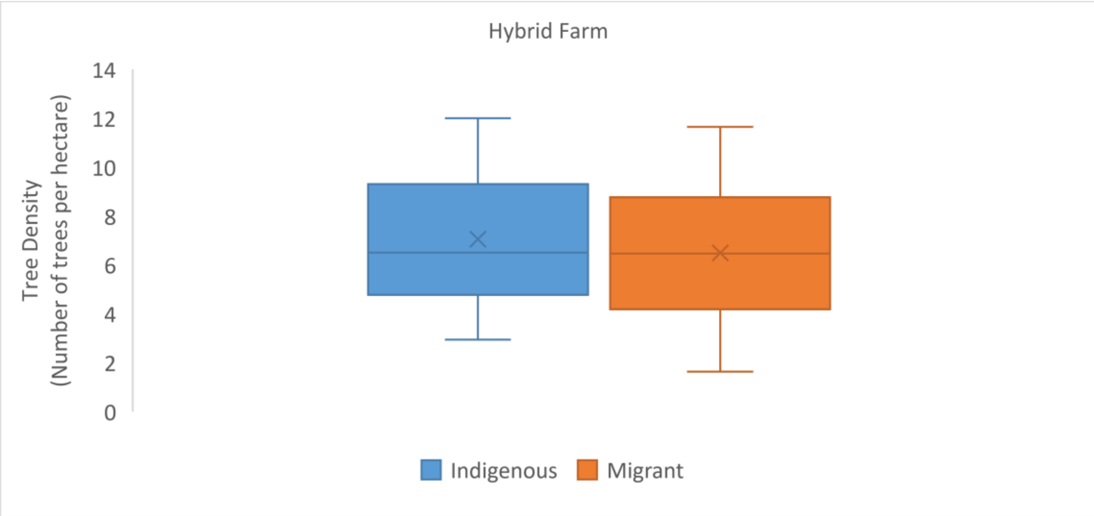

Figure 3-8 Difference between shade tree density of indigenous and migrant farmers involve in the hybrid system

The differences between the shade tree density of the indigenous and migrant were significant (P= 0.006). This prompted further analysis between the hybrid indigenous and hybrid migrant farmers. This was repeated for all the different types of farming systems. There was no significant difference between hybrid indigenous and hybrid migrant farmers (P=0.504). Also, there was no significant difference between indigenous mixed and migrant mixed farmers (P= 0.545). However, there was significant difference between indigenous traditional and migrant traditional farmers (P= 0.004).

3.2.4. Tree density and Farm age

The shade trees density of the traditional farms increased marginally with ages of the farms. The slope of the line very weak with $R^2 = 0.0824$ (Figure 3-9). The shade tree density of the mixed decreased slightly with the ages with a weak slope $R^2 = 0.124$. (Figure 3-10). With the $R^2 = 0.0003$, there was a very weak slope of the line of the ages of farms and the density of trees in the hybrid farms

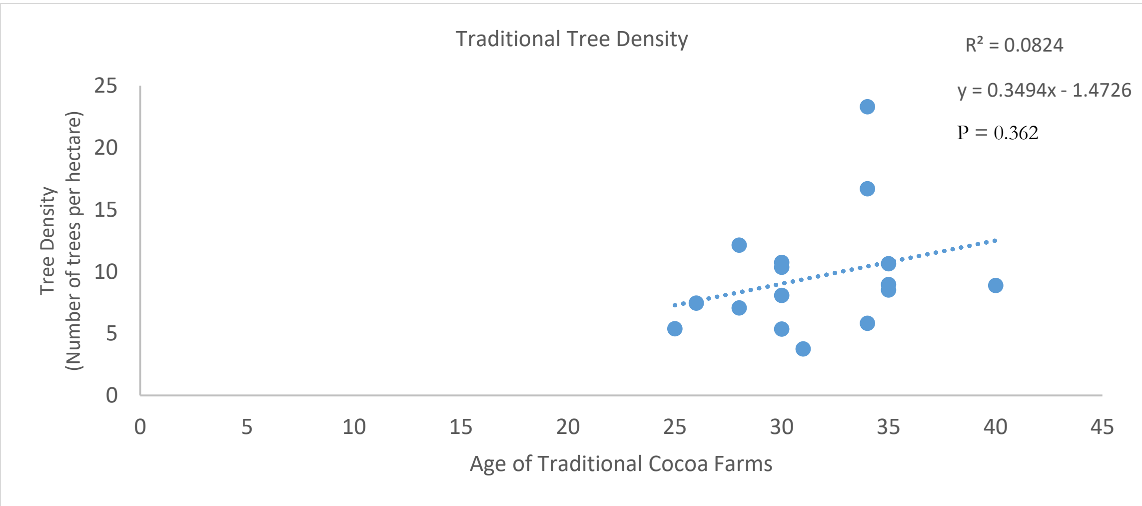

Figure 3-9 The relationship between the age of traditional farm and shade tree density

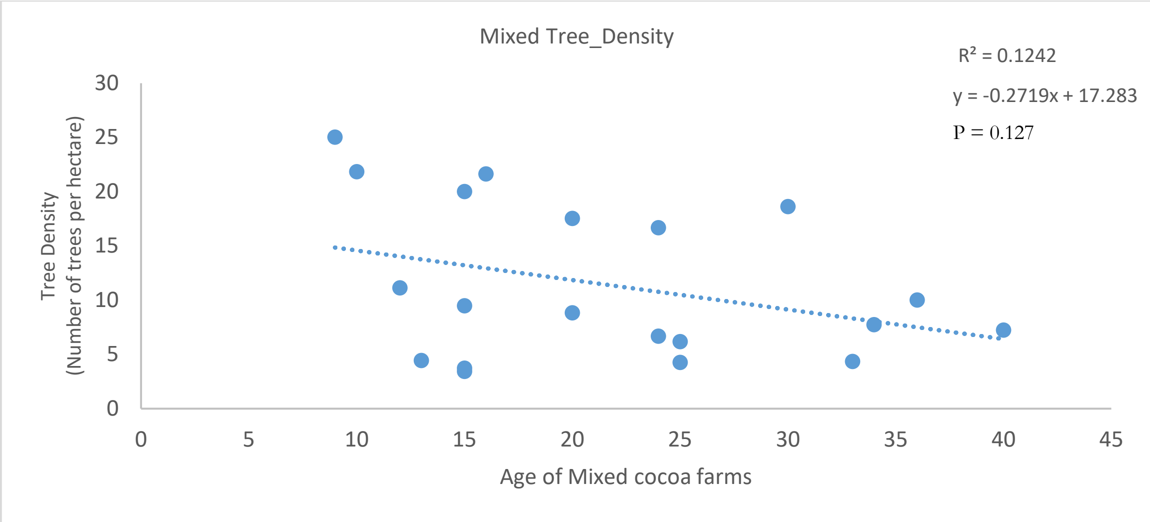

Figure 3-10 The relationship between the age of mixed farm and shade tree density

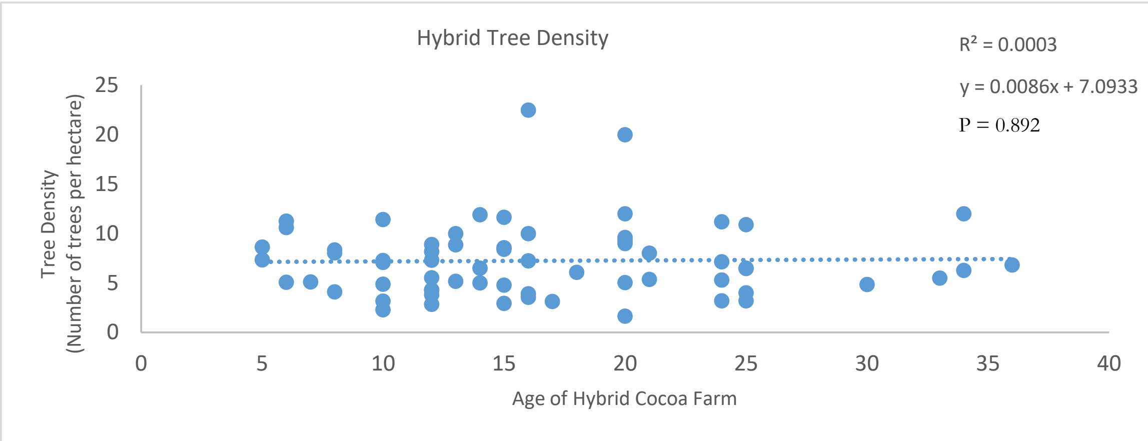

Figure 3-11 The relationship between the age of hybrid farm and shade tree density

3.2.5. Tree Density and Farm Perimeter

The relationship between the shade tree density of the farms and the farm perimeter was found to be very weak except that of the mixed farm system. The traditional, hybrid and the mixed farming system were with R^2 values of 0.31, 0.23, and 0.55 respectively. The shade tree density of the mixed farm had the highest R^2 value. Figure 4-12, 4-13, and 4-14 show the relationship between the shade tree density and the perimeter of traditional, hybrid and mixed farms respectively.

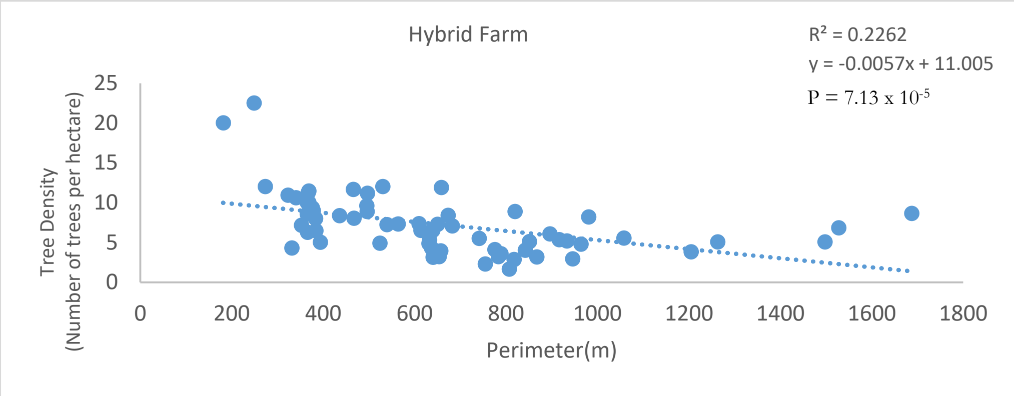

Figure 3-12 The relationship between shade tree density and farm perimeter of hybrid system

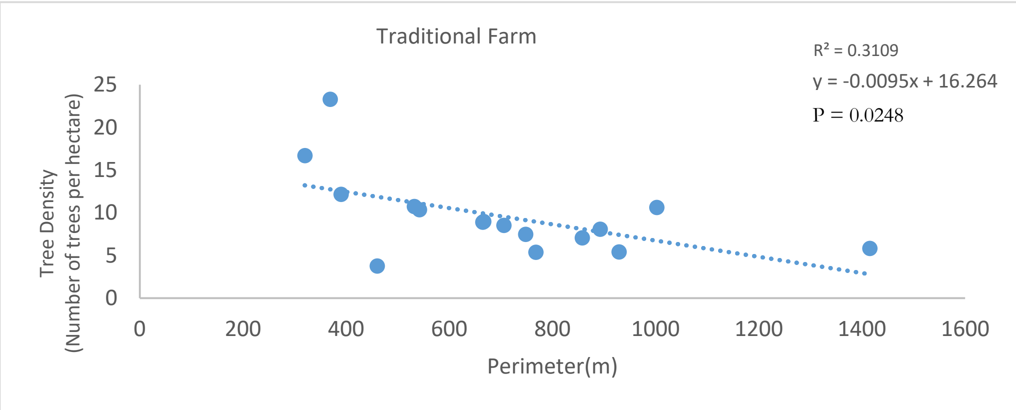

Figure 3-13 The relationship between shade tree density and farm perimeter of traditional system

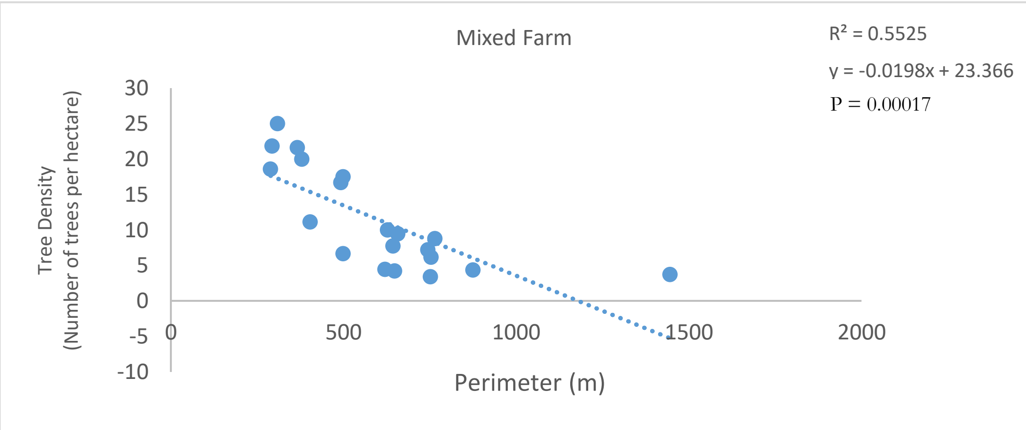

Figure 3-14 The relationship between shade tree density and farm perimeter of mixed system

Among the four (4) communities, Ayumso community recorded an average shade tree density of 11.49 trees per hectare. These shade tree densities of Ayumso was higher than the other three (3) communities. Fawohoyeden community recorded 7.98 trees per hectare. Goaso-Nkrankrom and Akrodie recorded average shade tree densities of 7.54 and 6.77 trees per hectare respectively (Figure 3-15). The attainment of this higher shade tree density by Ayumso alluded to strict adherence to communal laws that persisted in these communities. A map of the shade tree density is depicted in Figure 4-15.

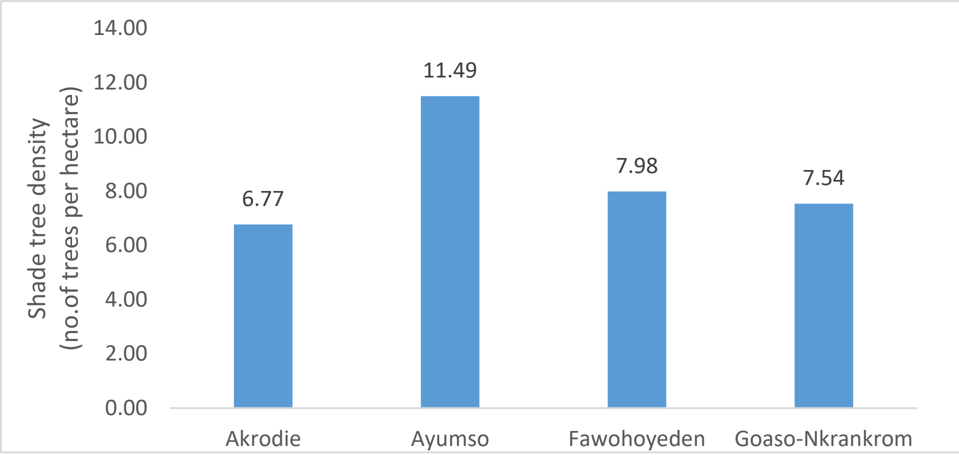

Figure 3-15 Average shade tree density per community

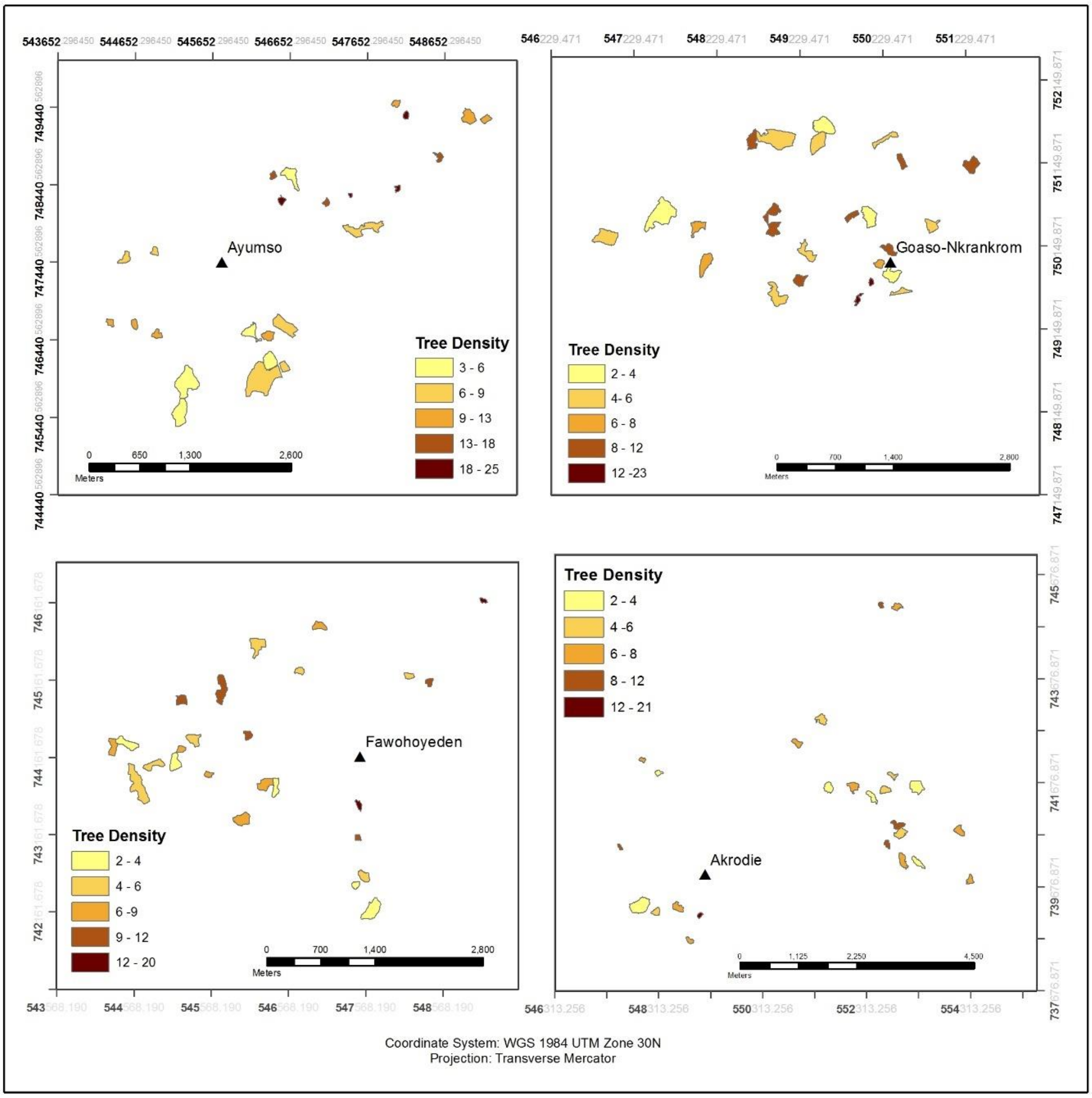

Figure 3-16 A map showing shade tree density of the four (4) communities

3.3. Motivational Factors for Retaining Shade Trees on Cocoa Farms

The identified motivational factors for retaining trees on the cocoa farm as mentioned by the farmers interviewed is plotted against the average scale of importance to the respondents (Figure 4-16). These motivational factors included biodiversity, climate change, soil quality improvement, investment for the future, tree planting scheme, provision of fertiliser, provision of tree seedlings, shade, construction of houses, fruits, to support yam (yam stake), and plant medicine. Of the twelve (12) motivational factors identified five (5) of them were often mentioned by the farmers i.e. shade, construction of houses, tree planting scheme, soil quality, and provision of tree seedlings (Figure 4-16). These five of the motivational factors were ranked high on the Likert scale because the farmers deemed these factors to be more important than the others. A statistical test was performed on the five (5) motivational factors which were often mentioned by the farmers. It was found out that there were statistical differences between the means of all the motivational factors for shade trees retention. The Kruskal-Wallis test for Soil quality improvement, tree planting scheme, shade, construction of houses, and provision tree seedlings are tabulated in Table 3-1 with the p-values. Because there were no significant differences between the three (3) groups of the farming types, it did not necessitate further test between pairs of groups.

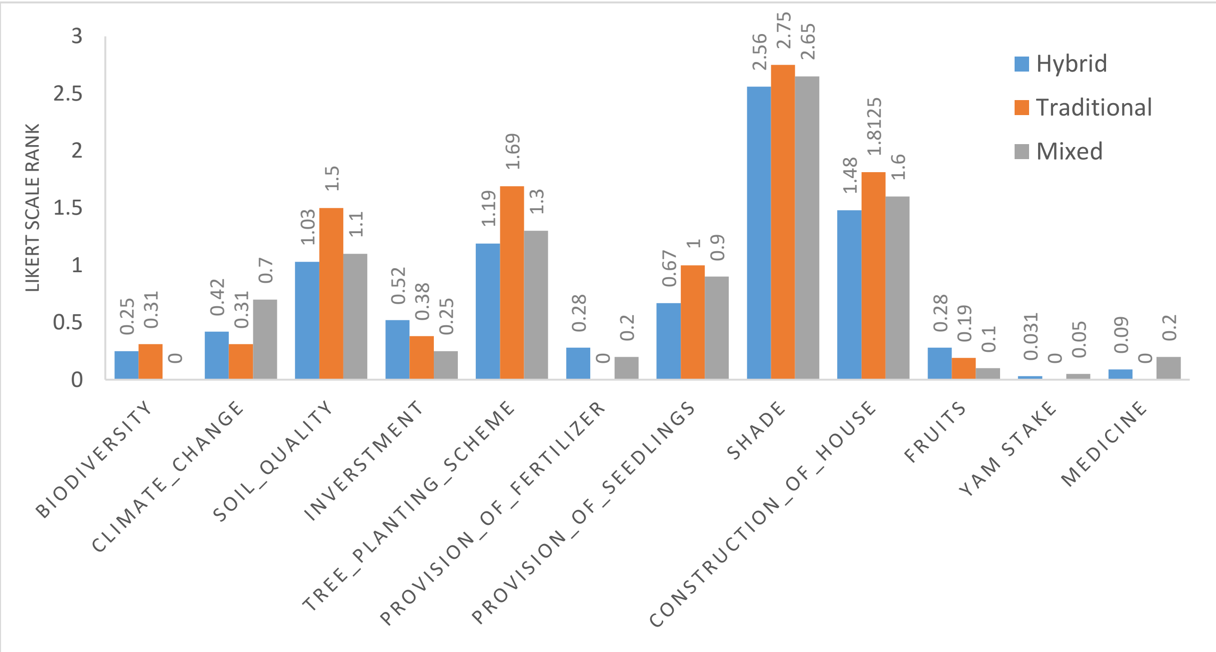

Figure 3-17 A bar chart showing motivational factors for shade tree retention

Table 3-1 P-values of differences between scores of different types of farmers for each motivational factor shade trees retention.

Motivational factors	P-value
Soil quality improvement	0.199
Tree planting scheme	0.273
Shade	0.199
Construction of houses	0.751
Provision of tree seedlings	0.348

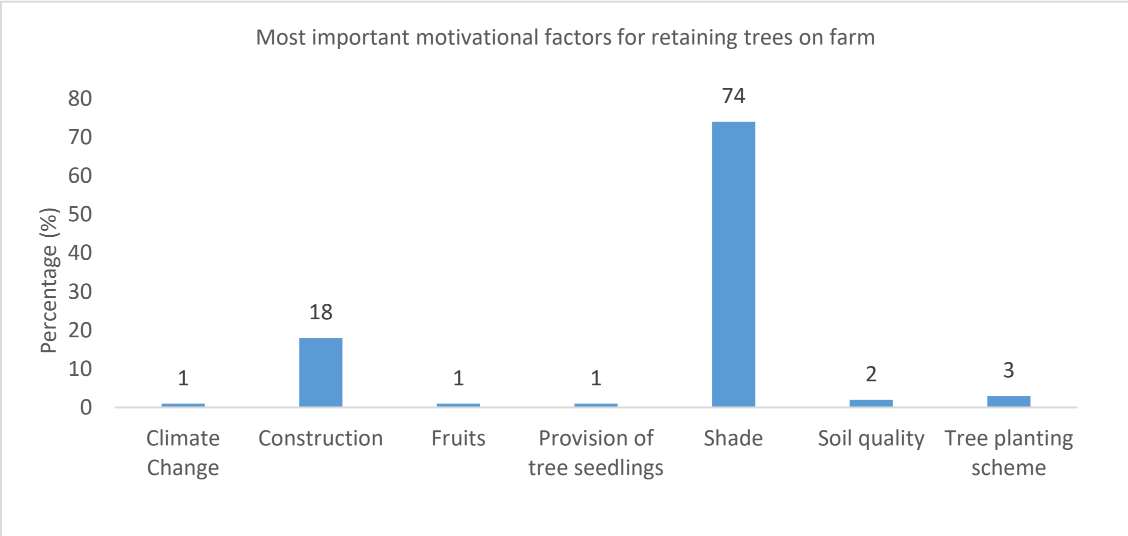

Figure 3-19 A bar chart showing first most important motivational factors for shade tree retention

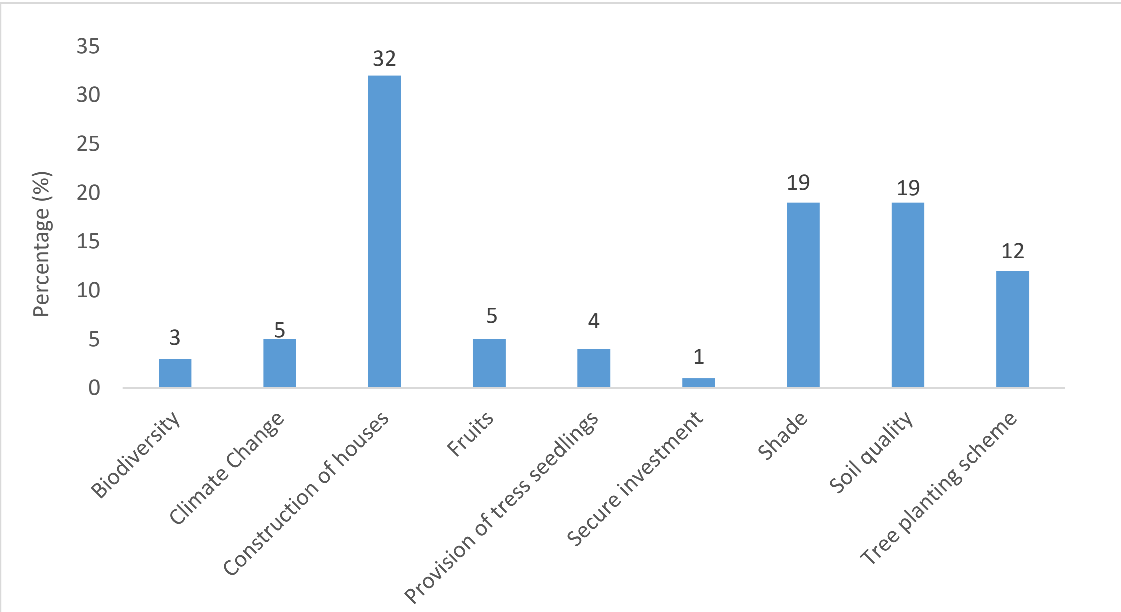

Figure 3-18 A bar chart showing the second most important motivational factors for shade trees retention

The cocoa farmers were asked to rank the three most important motivational factors for retaining shade trees on cocoa farms, and shade was ranked the first most important motivational factor as shown in Figure 4-17. Retaining shade trees for construction of houses was ranked the second most important motivational factor (Figure 3-18).

3.4. Motivational factors for removing trees on farm

The farmers identified six (6) motivational factors for the removal of shade trees from the cocoa farms. These were i) the destruction of cocoa crops by loggers, ii) not benefiting from the sale of merchantable shade trees, iii) non-payment compensation by loggers, iv) pest and diseases, v) Over-shading, and vi) Removal for construction. Figure 4-18 shows how farmers scaled these motivational factors for removing trees depending on their importance using the Likert scale. A comparison between the means of the scaled motivational factors was performed. There were no significant differences between the groups except for pest and diseases and over-shading (Table 3-2). The significant differences between the groups for over-shading and pest and diseases prompted further comparison between the groups to determine which of the groups have the differences. The further test showed insignificance for pest and diseases but significant for over-shading. There was a significant difference between the groups of the traditional farmers and the hybrid farmers for over-shading (P = 0.032) However; there was no significant difference between the groups for pest and diseases (P = 0.918).

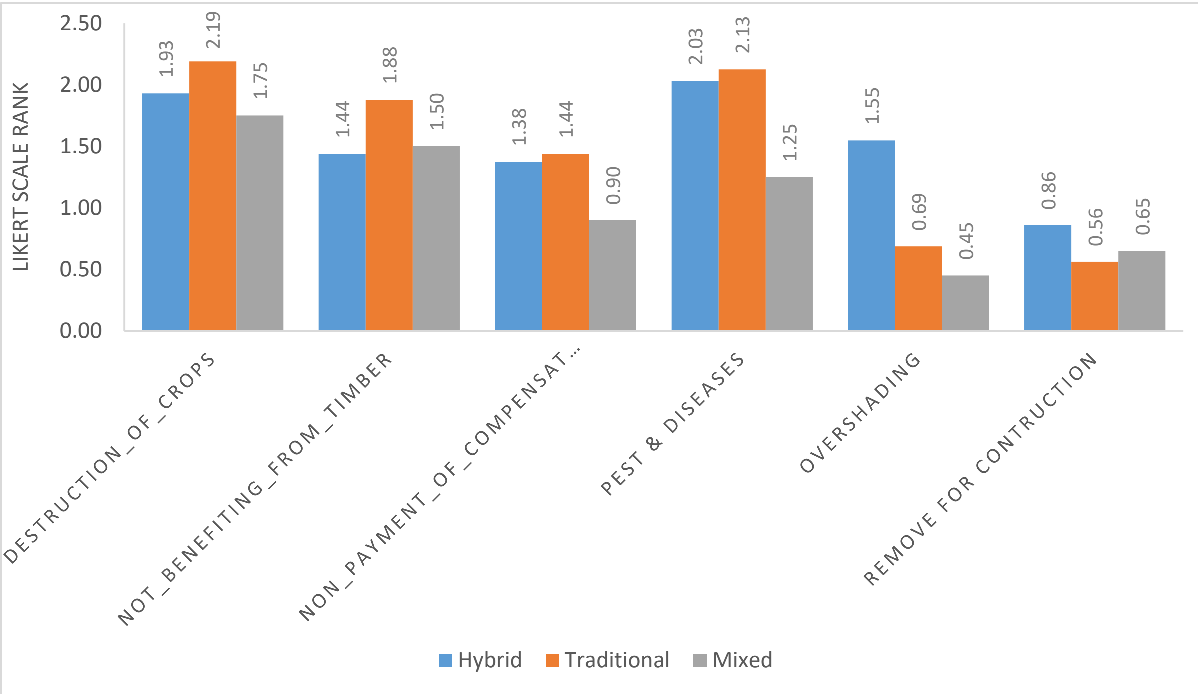

Figure 3-20 A bar chart showing motivational factors for shade trees removal

Table 3-2 P-values of differences between scores of different types of farmers for each motivational factor for shade tree removal.

Motivational factors	P-value
The destruction of cocoa crops by loggers	0.449
Not benefiting from the sale of merchantable shade trees,	0.385
Non-payment compensation by loggers	0.189
Nest and diseases,	0.30
Over-shading	0.003
Remove for construction	0.322

Pest and disease were ranked the first most important motivational factor for removing shade trees on the farms (Figure 4-19). The second most important motivational factor for removal of shade trees from cocoa farms was the destruction of cocoa crops during logging (Figure 3-21).

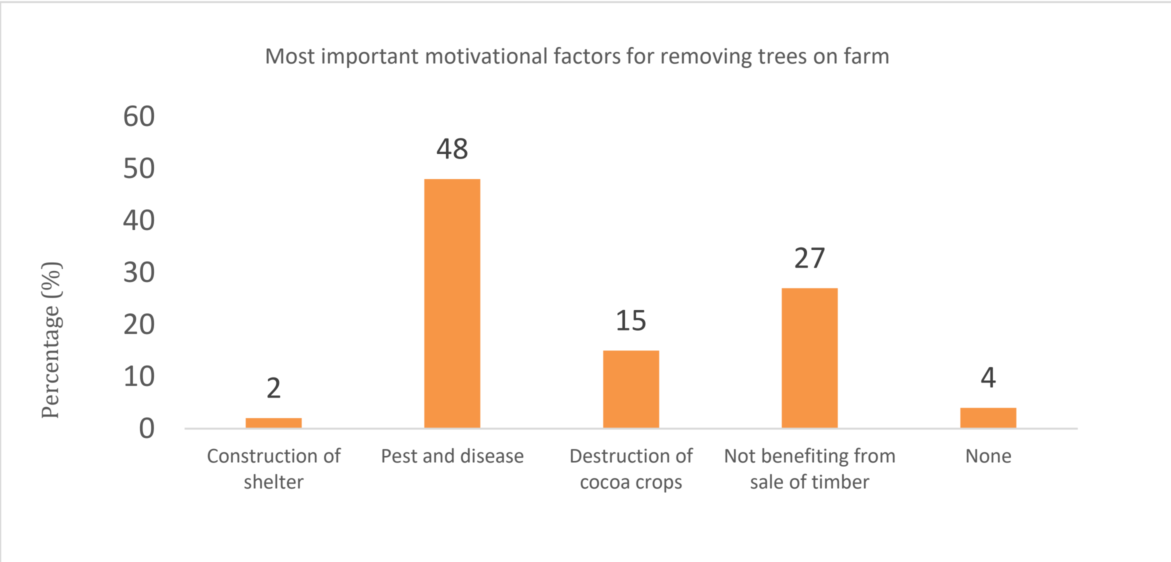

Figure 3-21 A bar chart showing the first most important motivational factors for shade trees removal

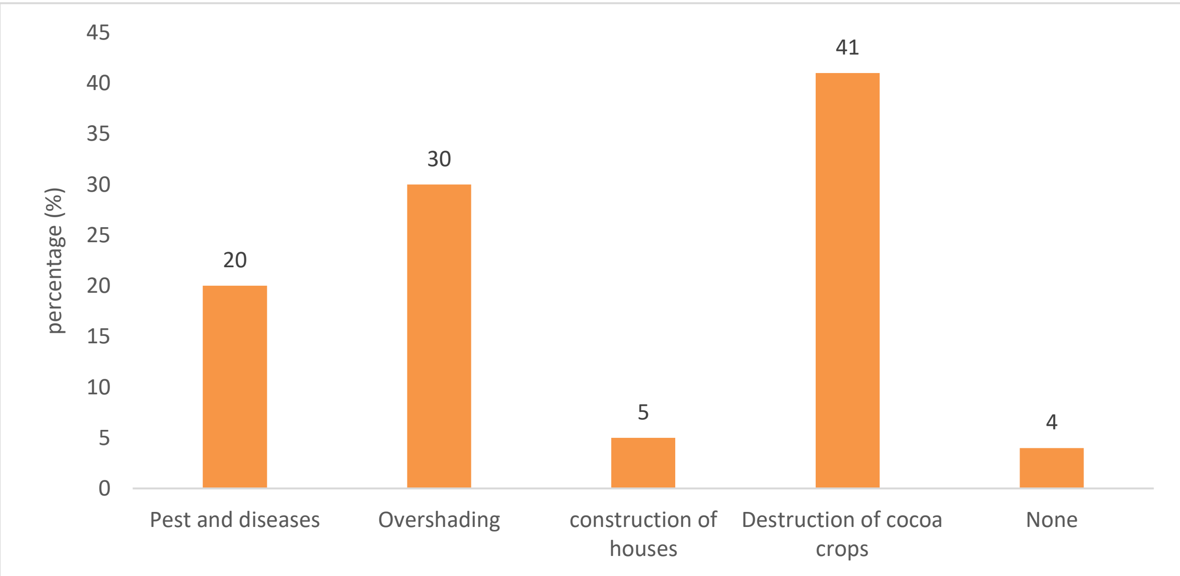

Figure 3-22 A bar chart showing the second most important factors for shade trees removal

4. DISCUSSION

This chapter deliberates the results of this study and offers conceivable reasons for the observations made. The chapter is in three sections; the first section deliberates on the farm sizes and factors affecting shade tree density, i.e. ages of farms, farm perimeter, the type of farmer, origin of farmer and gender of the farmer. The second and the third section presents the motivational factors for shade trees retention and removal of shade trees respectively.

4.1. Farm sizes

The cocoa farm sizes in this study were between 0.2 to 12 hectare reflecting the farming situations in Ghana. A study by Anim-Kwapong & Frimpong, (2005) revealed that cocoa farms are rather of small sizes between 0.4 to 4.0 hectare These relatively small sizes can be explained by the mode of acquisition of farmland. The farmlands were acquired through either lease or gift or inherited or outright purchase. Only 12% could afford the outright purchase. In a situation where the farmer purchased the farmland, there is the possibility to purchase a large tract of land depending on the worth of the individual. Most of the cocoa farmers were impoverished, hence they could not purchase outright farmlands. They have to undertake a lease contract or inherited the farmland from family relations. This underscores the high percentage of farmers acquiring farmlands through lease and inheritance.

4.1.1. Shade tree density

The shade tree density recorded from this study was between 1-25 trees per hectare. This was lower than what Anglaaere et al., (2011) obtained in a study conducted in Atwima district of Ghana, where shade tree density was between 15 – 43. However, Ruf, (2011), obtained shade tree density in the range of 1-14 shade trees per hectare in a study conducted in Western and Eastern Region of Ghana which was slightly lower than results attained this study. The minimum shade tree density obtained by Ruf, (2011) was attributed to intentional removal to increase the production of the hybrid (full-sun cocoa). The average shade tree density recorded were 7.24 per hectare for hybrid farms and 9.55 trees per hectare for traditional farms. The difference between them was statistically significant. This significant difference is an indicative that the farmers involved in the traditional system preferred to have a lot of shade trees than those farmers involved in the hybrid system.

4.1.2. Traditional authority and natural resource management

The traditional authorities possess some significant powers in the allocation of timber resources in Ghana (Kotey et al., 1998). The timber merchants have to pay homage to the chiefs or community leaders before any timber operations are carried on in his "area" i.e. the land area of his traditional authority. The chiefs possess that power to stop a timber operation without due respect for them. Therefore, in communities where the chiefs are powerful and well respected, the by-laws governing natural resources management are strictly enforced. The strict enforcement of these by-laws by the chiefs' influence and affect the density of shade trees. This is reflected in the results attained this study. The farmers attested to the fact that community heads in these communities do not condone illegal chainsaw lumbering. The farmers also said they fiercely fight illegal loggers and prevent them from felling merchantable trees from their farms.

4.1.3. Gender and shade trees

On the average male cocoa farmers had more shade trees on their cocoa farms compared to female farmers. This confirms the findings of Asare, (2016) where he asserted that the gender of cocoa farmers significantly determine the density of shade trees on the farms. He further explained that it is a requirement of forest policies in Ghana for loggers to compensate farmers for crop damage suffered during logging of merchantable trees from their farms. He added that there is no proper mechanism to determine the compensation to be paid to farmers (Asare, 2006). Hence, loggers refused to pay sufficient compensation to farmers when they destroy their crops. This setback requires farmers with excellent negotiation skills and ability to protect merchantable shade trees from been harvested by logging companies. Again, customary rights in Ghana make female farmers vulnerable in defending and negotiating for compensation with loggers. In order to avoid hostility from loggers during harvesting, female farmers remove these shade trees by charring or girdling before loggers aim them for timber (Asare, 2016). Therefore, retaining economic merchantable shade trees on cocoa farms demand institutional framework which backs the protection of such shade trees.

4.1.4. Migrant and indigenous farmers

It was observed that native farmers practising the traditional cocoa system retained more shade trees than the migrant farmers. There was a significant difference between the shade tree density of indigenous and migrant traditional cocoa farmers. The indigenous traditional cocoa farmers had an average shade tree density of 14.1trees per hectare which was higher than that of migrant traditional cocoa farmers of 9.12 trees per hectare. This significant differences could be due to tenurial arrangement and insecurity. In Ghana, migrants are unwilling to invest in enduring management policies as a result of tenure insecurity and short duration of land rent, since migrant farmers are not guaranteed to earn the full benefits of long-term management strategies. (Samuel Adjei-Nsiah et al., 2007). According to Damnyag et al., (2012), insecurity of tenure of leasehold and sharecrop land holding farming give way to deforestation, particularly in an agricultural landscape. On the other hand, chainsaw operators (illegal loggers) easily target merchantable shade trees in the farms of migrant farmers. These problems reduce the shade trees density in the farms of migrant cocoa farmers.

4.1.5. The ages of the cocoa farms

The ages of the cocoa farms in this studies range between 5 – 40 years. The cocoa plant is economically productive between the ages of 4 and 40 years (Obiri et al., 2007). Analysis of shade tree density and ages of the three types of the farming systems indicated that shade tree density of hybrid cocoa farming system does not change with the age of the farm. However, mixed farm decreased slightly with the ages of the farms while that of the traditional cocoa farming system seemed to be increasing with the ages of the farm. This is because the mixed farms were undergoing a transition from the traditional to the hybrid system at a slow pace. Hence, the farmer may remove the shade trees to decrease the shade on the farm, while increasing the cocoa yield of the new hybrid cocoa variety. The shade trees in hybrid systems are purposely removed to boost yield production (Anglaaere et al., 2011). However, the retention of constant shade trees in the hybrid system meant that farmers possess some indigenous knowledge that shade aid in the sustenance of their cocoa farms. Under the ages of three (3) years the cocoa plant requires shade to survive according to Alvin, (1977), as cited in Asare, (2015), cocoa farmers turn to remove shade trees for the cocoa plants to bear fruits at later ages of the farm. The available data did not support this claim since all the sampled farms were above 3 years. Therefore, there is no evidence that farmers choose to remove shade trees when the cocoa is ageing.

4.1.6. The farm perimeter and age of farm

The decrease in the shade tree density with the increased perimeter of the farm is evidence that shade trees were not only found in the centre of the farms but were found more at the peripheries of the farms. The occurrences of shade trees on the farm boundary explain the shade tree density decrease with the increase in farm perimeter. These shade trees are serving another purpose apart from providing shade; as cocoa farmers plant these shade trees to separate or distinguish between two farms belonging to two different people. Shade tree also served as boundary planting, which does not crowd shade trees at the centre of the cocoa fields.

4.1.7. Types of farming systems

With regards to the differences in shade tree density in cocoa farming systems, it was obvious from the results that traditional farming system had higher shade tree density compared to the hybrid system of the cocoa farming. The traditional cocoa, the "Amazons" and "Amelonado" requires shade to grow well, it needs an absolute minimum of shade, since overexposure to sunlight impairs the photosynthetic mechanism of the leaves according to Raja Harun and Hardwick (1988) as cited by (Asare, 2016). On the other hand, the hybrid variety (Series 2) is reported to be "sun loving" and requires the removal shade trees to boost yield production (Asare, 2016). The high shade tree density in the traditional cocoa farming system cannot be overemphasised though statistically, there was a significant difference between them. Surprisingly, farmers with the hybrid cocoa system were having average shade tree density of 7.24 trees per hectare. This high shade tree density of the hybrid system indicates the hybrid farmers were also interested in the shade trees. The cocoa farmers indicated that when the cocoa plant is exposed to excessive sunlight, the cocoa plants wither during the dry periods. This might have contributed to the retention of shade trees also on the hybrid cocoa farms.

The shade trees density in the mixed farms (traditional and the hybrid) was higher than both the traditional and the hybrid cocoa system. These mixed cocoa farms were old traditional cocoa farms undergoing a transition to the hybrid. This transition was noticed to be at a very slow pace since farmers tend to remove old and unproductive traditional cocoa trees from the farm and replace it with the new hybrid cocoa by cutting the unproductive old traditional cocoa. Most of the mixed farms were also abandoned old farms that have been overgrown with bushes and therefore had a lot of saplings turned to trees. The cocoa farm undergoing rehabilitation require a lot of shade to protect the newly planted cocoa, hence the higher shade tree density.

4.2. Motivation for retaining shade trees on cocoa farms

Undoubtedly, shade trees in cocoa production system play a significant role in the cocoa agroecosystem. Some studies recognise the numerous advantages and disadvantages of shade trees in cocoa fields (Asare, 2015; Asare & Prah, 2011; Vanhove, Vanhoudt, & Van Damme, 2016; Hoogendjik, 2012; Beer et al., 1998; Vaast & Somarriba, 2014). Retaining shade trees on cocoa fields are influenced by several motivational factors affecting the cocoa farmers. According to Anglaaere et al., (2011), retaining a particular shade tree on the cocoa field depends on the preferences and the usefulness of that shade tree to the farmer.

The result of this study brought to light twelve (12) motivational factors that influence the presence of shade trees on mixed, hybrid and traditional cocoa systems. Out of these twelve (12) motivational factors, seven (7) of them were predetermined before going to the field. The seven (7) were (i)climate change mitigation purpose, (ii)biodiversity sustenance, (iii)soil quality improvement, (iv)as an investment for future, (v)tree planting scheme, (vi)the provision of fertiliser, (vii)the provision of tree seedlings. The farmers confirmed the predetermined motivational factor and identified additional five (5) motivational factors for shade tree retention which included, (i)shade provision, (ii)construction of houses, (iii)fruits, (iv)yam stake (to support yam plant), (v)and plant medicine. Four (4) of the motivational factors were often mentioned by all the different farmers i.e. mixed, hybrid and traditional cocoa farmers in the study area. These were the soil quality improvement, tree planting scheme, shade provision, provision of tree seedlings, and construction of houses. This outcome supports the findings of Oduro, (2016) that farmers would engage themselves in on-farm tree plant due to tree planting schemes. He showed that cocoa farmers are aware of current environmental issues and would retain on-farm trees on their cocoa farms. However, current environmental issues such as biodiversity, climate change were not often mentioned by the farmers in this study. The improvement of soil quality, shade, and construction of houses were motivational factors farmers considered before retaining shade trees on their cocoa farms. With soil quality improvement and shade, this confirms the findings of Smith Dumont, Gnahoua, Ohouo, Sinclair, & Vaast, (2014), where cocoa farmers valued the integration of variety of shade trees on their cocoa farms because they alleged that shade trees "protected cocoa from water stress in the dry season and improved soil fertility".

Several studies show that shade trees are removed to increase the yield of the hybrid variety. However, the cocoa farmers in this study area kept an average of shade tree density of 7.24 trees per hectare. The unusual attainment of this "high" shade tree density on the hybrid cocoa was motivated by shade requirement. Both hybrid and traditional cocoa farmers did not miss words that shade was the main motivational factor for the non-cocoa trees on their cocoa farms. The hybrid farmers also valued the shade provided by these non-cocoa trees. Obiri et al., (2007), showed that the economic rotation age of hybrid cocoa system increases from 15 years to 25 years when shaded. This outcome of Obiri et al., (2007) could be the primary reason for hybrid cocoa farmers to retain shade trees on their farms since the cocoa farmers suggested that without the shade over their cocoa farms, the cocoa plants wither during the dry periods of the year.

It is established that the aboveground carbon stock in cocoa growing region exceeds that of natural forest in southern Bahia (Schroth et al., 2015). In both hybrid and traditional system, cocoa farms in the Eastern Region of Ghana could store between 118.6–223.2 Gg C (Mohammed et al., 2016). Carbon stock in cocoa agroforestry system cannot be done away with when it comes to climate change mitigation as cocoa farmers in Ghana recognise this important contribution of the cocoa sector. The traditional cocoa agroforestry system of cocoa farming contribute significantly to the conservation of biodiversity (Schroth et al., 2015). Though environmental issues such as carbon sequestration and biodiversity were not often mentioned by the cocoa farmers in the study area, some of the farmers were able to identify the contribution of shade trees in cocoa farms to provide habitat animals to sustain biodiversity. Some of the farmers recognise the importance of biodiversity, but that was not a major motivational factor for shade tree retention (see Figure 3-16).

4.3. Motivational factors for removal shade trees on cocoa farms

Usually, for the purposes of fuelwood, poles, pestles, etc. farmers remove trees from farms. These are materials that are used in everyday life of a Ghanaian cocoa farmer. However, the farmers remove or kill non-cocoa trees also due to other motivational factors such as policy intervention or enforcement of legislations (Oduro, 2016). Unshaded cocoa system and intensification are on the increase. Non-involvement of technological innovations in cocoa farms by smallholder cocoa farmers with little results has resulted in a low yield of cocoa (Vaast & Somarriba, 2014). According to Appiah et al., (2009), cocoa farmers have less priority to environmental issues in Ghana. The less prioritisation for environmental issues contributes to the removal of shade trees from the cocoa farms. The uttermost removal shade trees from the cocoa landscape in the quest to boost productivity at the detriment of environmental issues (e.g. biodiversity and carbon sequestration) prompted the institutionalisation of cocoa certifications (Vaast & Somarriba, 2014).

The study identified six (6) common motivational factors that encourage them to remove shade trees on their cocoa farms. These are (i) destruction of cocoa crops during harvesting of merchantable shade trees by loggers, (ii) Not benefiting from sale of timber to logger by the government of Ghana, (iii) Non-payment of compensation to farmers, (iv) Pest and disease associated with shade trees, (v) over shading and removal of shade trees for construction of houses. These are the primarily the motivational factors influencing the cocoa farmers to remove shade trees on the cocoa fields. The revelations of this study confirm the findings of Oduro, (2016) as the major hindrances to on-farm tree planting and management in the Western Region of Ghana. The main motivational factors for removing shade trees as mentioned by most of the farmers (hybrid or traditional) related to cocoa crops damage during harvesting of the merchantable trees and not sufficiently being compensated. Pest and disease was identified as the most important factor for removing shade trees. Therefore, eliminating these constraints would be a very good way to improve shade tree density on cocoa farms. Only for the hybrid farmers, also, over-shading was an issue.

There is a multifaceted usufructuary right of timber trees in agriculture landscape (Damnyag, Saastamoinen, Appiah, & Pappinen, 2012). The shade trees regenerating naturally on farms are held in trust by the state on behalf of the people; this does not grant logging right to landowners and farmers. However, logging rights are granted to concessionaires to log the merchantable shade trees found on the farmlands. The proceeds are paid to central government, and farmers who nurtured such tree are left out of the revenue from the sale of such trees (Kotey et al., 1998). From the findings of this study it could be noted that apparently, the extraction of timber from agricultural landscape was a major concern to the cocoa farmers. The damages of the cocoa plant resulting from harvesting and hauling the timber through the farm take a very long time to improve from this physical injury (J Beer et al., 1998). In situations where merchantable shade trees are felled from cocoa fields, and farmers are not sufficiently compensated motivates the cocoa farmers to remove these shade trees from their cocoa fields before they become too big. The biggest of the problem is the biased distribution of monetary revenue accumulating from timber harvesting in Ghana. The allocation of timber revenue (royalties) in Ghana is as follows "District Assembly (55%) and to a lesser extent office of the administrator of stool land (25%) and the local authorities (20%) to the detriment of true landowners and local communities at large" (Danquah, Kuwornu, & Pappinen, 2013). Hence, the farmers or the farmland owners are not allowed to benefit directly from the monetary revenue from these trees that are legally permitted to be harvested (Kotey et al., 1998; Acheampong & Marfo, 2011). This policy regime and this discriminating legislative framework have hastened illegalities in timber extraction particularly in the agricultural landscape (Hansen & Treue, 2008). Therefore, cocoa farmers are motivated to eliminate naturally regenerated timber trees (shade trees) since logging companies that attain legal permits to extract these on-farm trees hardly pay satisfactory compensation to farmers for damages to cocoa crops (Amanor, 1996) as cited in Oduro, (2016).

Exessive shade trees and non-compatibility of certain shade trees resulted in pest and diseases in the view of the farmers and that leads to low crop yield. Zubair & Garforth, (2006) posited that certain shade trees harbour insects, pests and diseases which impact negatively on cocoa crop yield. This accounts for the reason why farmer ranked pest and diseases as the most important motivational factor for removing shade trees (see Figure 3-21). Although all the types of farmers were motivated to remove shade trees as a result of over shading, hybrid farmers were more sensitive to this issue. Hybrid cocoa variety requires more sunlight to boost yield production compared to the traditional variety. Over-shading is said to increases the humidity of the cocoa farm which favours *Phythphora palmivora* (black pod), a cocoa disease reported by Dakwa, 1980 as cited in (J Beer et al., 1998). Hence the removal of shade trees to reduce over shading and crowdedness of trees on the cocoa farms.

The removal of shade trees for construction of houses is done by all the farmers of the all the farming systems. The cocoa farmers were motivated to retain shade trees for construction of houses, and again they were motivated to remove for house construction. The net effect of this motivational factor in terms of carbon storage is zero since the motivation for retaining is taken away by removing it again. The farmers were of the view that once loggers come to harvest the timber from their farms without any benefit, they would not nurture timber trees and while they go to buy lumber from commercial market to roof their houses.

5. CONCLUSION AND RECOMMENDATION

The main objective of this study was to examine the motivational factors to remove or retain shade trees on cocoa farms for REDD+ implementation in the Goaso Forest District. The conclusion is presented in the sequence of the research questions and the hypothesis.

1. **Are there differences in shade tree density between hybrid and traditional cocoa farms?**
   Hypothesis: There is a significant difference in the density of shade trees between farmers with traditional and hybrid cocoa varieties.

   For research question 1: There were differences in the shade tree density between the hybrid and the traditional systems. Since the average shade tree density obtained for the traditional cocoa, system was 9.55 trees per hectare, and that of hybrid system was 7.24 trees per hectare. Statistically, there was a significant difference between the shade tree density of both systems

2. **Are there differences between the motivational factors to retain shade trees between farmers of hybrid and traditional cocoa varieties?**
   Hypothesis: There is a significant difference in the motivational factors to retain shade trees between farmers of traditional and hybrid cocoa varieties.

   For research question 2: There were no differences by between the motivational factors for retaining shade trees in cocoa farms. The motivational factors for shade trees retention identified in this study were twelve (12) in all the systems. Statistically, there was no significant difference between the all the three systems for the five (5) most commonly mentioned by the farmers. The most important reason to retain shade trees was the provision of shade to cocoa crops.

3. **Are there differences between the motivational factors to remove the shade trees between farmers of hybrid and traditional varieties?**
   Hypothesis: There is a significant difference in the motivational factors to remove shade trees between farmers of traditional and hybrid cocoa varieties.

   For research question 3: There were no differences between the motivational factors for removing shade trees on cocoa farms except for over-shading. Six (6) motivational factors were identified for shade trees removal. Of all the motivational factors identified for shade trees removal from the cocoa landscape, only over shading was statistically significant. The results showed there were no significant differences for the rest of the factors.

The result of this study shows that cocoa farmers are motivated to retain shade trees on their cocoa farms (both hybrid and traditional) because of the shade provision shade. On the other hand, farmers (both hybrid and traditional) are motivated to remove shade trees because of diseases and pest infestation, coupled with lack of compensation from loggers and the damage cocoa crops suffer during harvesting of shade trees as timber on the cocoa farms. Hence, removing these constraints would improve the shade tree density of the cocoa farms considerably. Only for the hybrid farmers, also over-shading was an issue.

Regardless of the small difference between the shade tree density of the hybrid and the traditional system, the continuous shift from the traditional system of cocoa to the hybrid poses a threat to REDD+

implementation in the cocoa landscape since shade tree density decreases in the hybrid cocoa system. However, in improving the carbon stock of the cocoa landscape, both systems should be targeted since all the cocoa farmers share common motivational factors for shade trees retention.

It is recommended that cocoa farmers are given more education in the light of current environmental issues and the importance of storing much carbon in the cocoa landscape to mitigate climate change.

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APPENDIX 1: QUESTIONNAIRE FOR COCOA FARMERS

Questionnaire for cocoa farmers

Interview No.: ……..   Date: …………… Name of Town: ……………………

Interviewer: ……………………………………

Farm No.: …………………………………….

Please tick where appropriate

SECTION A: RESPONDENT'S BACKGROUND

1. Age: ………… Sex: Male/Female
2. Educational Level: No Education/Primary/JHS/SHS/Tertiary/Others (Specify) …………
3. Marital Status: Single   Married   Widowed   Divorced
4. How long have you stayed in this community? …………..   indigene/migrant?
5. How many children do you have?   …………..

SECTION B: FARM OWNERSHIP

6. Is the farm yours? Yes/No
7. If yes, how did you acquire the land? Purchase; Inherited; Lease; Gift;
8. If it is a lease, what is the lease agreement? ……………
9. What percentage of your annual income come from a cocoa farm? …………………..
10. What is the cocoa variety you have? Traditional /Hybrid
11. If traditional, why?...............................
12. If hybrid, why?..................................
13. How old is the farm?...........

SECTION C: RETAINING TREES ON FARM

1. Do have big trees on your cocoa farm? Yes/No
2. Why do you keep the trees on the farm?

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

3. Should the government offer you money or incentives to keep trees on your farm, would you? Yes/No
4. If yes, how much? ……………………………………………..
5. What about the following factors, will they encourage you to retain trees on your cocoa farm? *(Rank, on a scale of 3 -0 with 3 being very important and 0 being the least important)*

No	**Motivation to retain trees**	**3**	**2**	**1**	**0**
1	Biodiversity				
2	Climate Change				
3	Soil quality				
4	As a secure investment				
5	Tree plant scheme				
6	provision of fertiliser				
7	provision of tree seedlings				
8					
9					

6. Rank the motivational factors that influence you to keep the shade trees

   i. …………………………………………………

   ii. ………………………………………………….

   iii. ………………………………………………….

   iv. ………………………………………………….

   v. ………………………………………………….

   vi. …………………………………………………..

SECTION D: REMOVING TREES ON COCOA FARM

7. What are some of the reasons that will push you to remove the big trees on your cocoa farm?
……
……
……
……
……
……
……………..

8. What about the following factors will they encourage you to remove trees on your cocoa farm? *(Rank, on a scale of 3 -0 with 3 being very important and 0 being the least important)*

No	**Motivation to remove trees**	**3**	**2**	**1**	**0**
1	Destruction of cocoa crops by loggers				
2	Nonpayment of compensation logging companies				
3	Not benefiting from sale of trees to loggers				
4					
5					
6					
7					
8					
9					

9. Rank the motivational factors that influence you to remove the shade trees

i. …………………………………………………..

ii. ……………………………………………………

iii. ……………………………………………………

iv. ……………………………………………………

10. Did you ever convert from one cocoa farm system to another? Yes/No
11. When did you convert? Date: ……………………………

12. Do you intend to convert to another system of cocoa farming?

……

……

……

……

…………

13. Is there anything I did not mention?

……

……

……

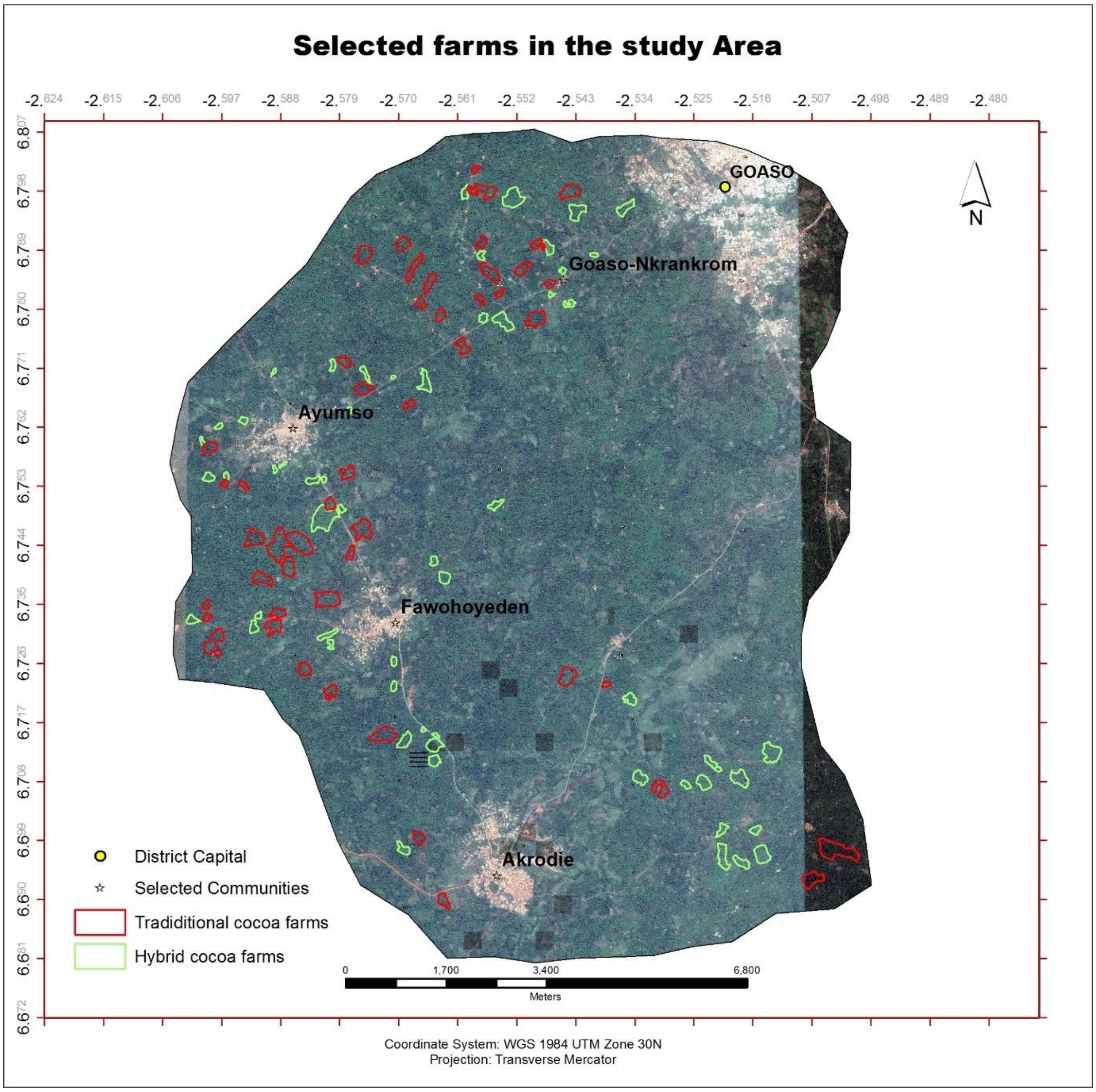
……

…………

APPENDIX 2: DATA SHEET

Data Sheet		
Farm No		
GPS waypoint starting point		
GPS waypoint ending point		
Plot Size		
Date		
No. of shade trees		
Observers Name		
No	**Tree species**	**Remarks**

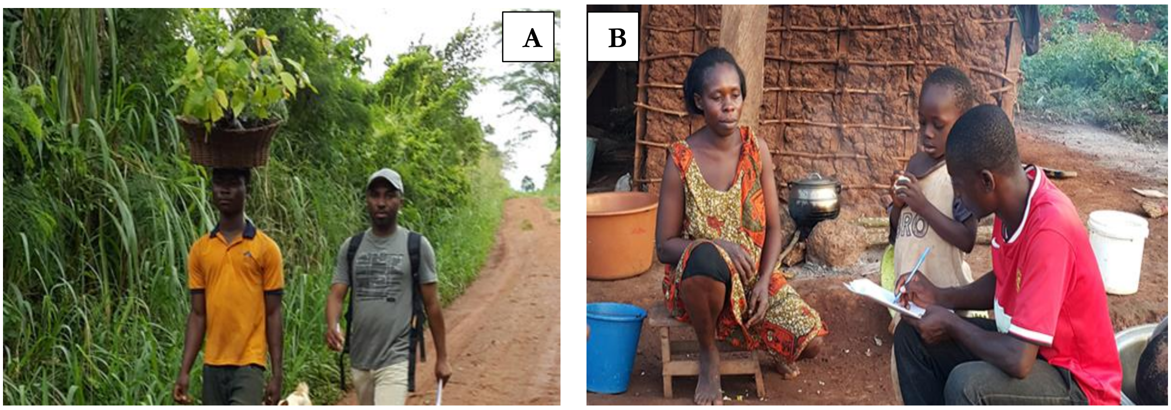
APPENDIX 3: A MAP SHOWING SELECTED COCOA FARMS



APPENDIX 4: TREE SPECIES FOUND ON COCOA FARMS

No.	Local name	Scientific name
1	Emire	*Terminalia superba*
2	Otie	*Pycanthus angolensis*
3	Onyina	*Ceiba pentandra*
4	Ofram	*Terminalia superba*
5	Kyenkyen	*Antiaris toxicaria*
6	Foto	*Glyphaea brevis*
7	Kyenkyen	*Antiaris toxicaria*
8	Fotum	*Funtumia elastica*
9	Wawa	*Triplochiton scleroxylon*
10	Nyankyeni	*Ficus exasperata*
11	Odum	*Milicia excelsa*
12	Pepia	*Margaritaria discoidea*
13	Kusia	*Bussea occidentalis*
14	Nyame dua	*Alstonia boonei*
15	Sesei	*Trema orientalis*
16	Konkroma	*Morida lucida*
17	Koto	*Zanthoxylum gilletii*
18	Mango	*Mangifera indica*
19	Akonkodie	*Bombax buonopozense*
20	Prekese	*Tetrapleura tetraptera*
21	Yaya	*Amphimas* sp
22	Pea	*Persea americana*
23	Teak	*Tectona grandis*
24	Woma	*Ricinodendron heudelotii*
25	Tweneboa	*Cordia platythyrsa*
26	Akye	*Blighia sapida*
27	Watapuo	*Cola gigantea*
28	Esa	*Celtis milbraedii*
29	Wawabima	*Sterculia rhinopetala*
30	Akasa	*Chrysophyllum albidum*
31	Sesemasa	*Newbouldia leavis*
32	Odwuma	*Musanga cecropioides*
33	Awiemfo semina	*Albizia coriaria*
34	Mansonia	*Mansonia altissima*
35	Edinam	*Entadrofragma angolense*
36	Ankaa	*Citrus sinensis*
37	Mahogani	*Khaya ivorensis*
38	Tweneboa	*Cordia platythyrsa*
39	Kuakunisuo	*Spathodea campanulata*
40	Pepia	*Margaritaria discoidea*
41	Okoro fitaa	*Albizia zygia*
42	Pampena	*Albizia adianthfilia*

APPENDIX 5: PHOTOGRAPHS WERE TAKEN DURING FIELD WORK



'A' On our way to a cocoa farm, 'B' a field assistant interviewing a cocoa farmer

'C' traversing a cocoa with GPS receiver, 'D' counting and identifying a shade tree.

Errata Page Benjamin Antepim-Appiah

NRM MSc 2015-2017

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1. On page 11 - Figure 3-1 should be **Figure 2-1**
2. On page 12 – Figure 3-5 should be **Figure 2-2**
3. On page 13 – Fifth paragraph the last sentence should be off.
4. On page 14 – Paragraph two section 3.7.2 should be **section 2.8.2**
5. On page 22 – The last paragraph Figure 4-15 should be **Figure 4-16**
6. On page 24 – First paragraph Figure 4-16 should be **Figure 4-17**
7. On page 25 - Last paragraph Figure 4-17 should be **Figure 3-19**
8. On page 26 – First paragraph Figure 4-18 should be **Figure 3-20,** on that same page in table 3-2, Nest should be **Pest** its p-value should be **0.030** instead of 0.30.
9. On page 27 – Figure 4-19 should be **Figure 3-21** and Figure 3-21 should be **Figure 3-22**
10. On page 31 – The third paragraph Figure 3-16 should be **Figure 3-17**

3.4 Motivational factors for removing trees on farm

The farmers identified six (6) motivational factors for the removal of shade trees from the cocoa farms. These were i) the destruction of cocoa crops by loggers, ii) not benefiting from the sale of merchantable shade trees, iii) non-payment compensation by loggers, iv) pest and diseases, v) over-shading, and vi) removal for construction. Figure 3-20 shows how farmers scaled these motivational factors for removing trees depending on their importance using the Likert scale. A comparison between the means of the scaled motivational factors was performed. There were no significant differences between the groups except for pest and diseases and over-shading (Table 3-2). The significant differences between the groups for over-shading and pest and diseases prompted further comparison between the groups to determine which of the groups have the differences. The further test showed insignificance for pest and diseases but significant for over-shading. There was a significant difference between the groups of the traditional farmers and the hybrid farmers for over-shading (P = 0.032) However; there was no significant difference between the groups for pest and diseases (P = 0.918).

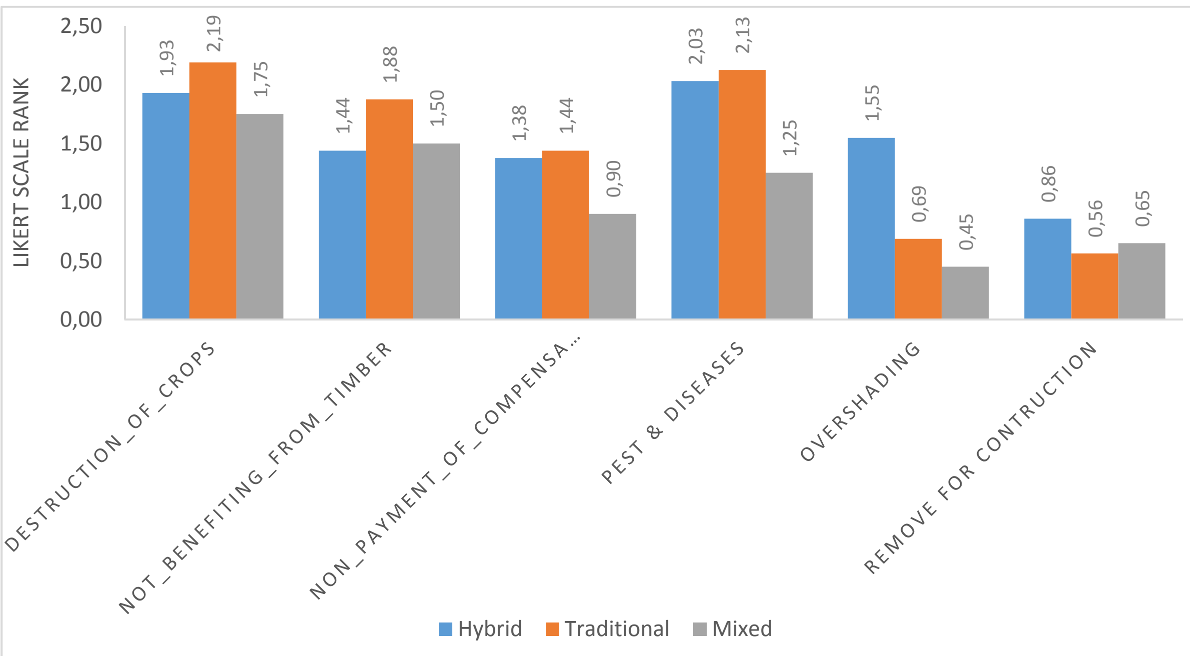

Figure **Error! No text of specified style in document.**-1 A bar chart showing motivational factors for shade trees removal

Table **Error! No text of specified style in document.**-1 P-values of differences between scores of different types of farmers for each motivational factor for shade tree removal.

Motivational factors	**P-value**
The destruction of cocoa crops by loggers	0.449
Not benefiting from the sale of merchantable shade trees	0.385
Non-payment compensation by loggers	0.189
Pest and diseases	0.030
Over-shading	0.003
Remove for construction	0.322