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**THESIS TOPIC**: ASSESSING THE ECONOMIC PERFORMANCE OF COCOA AGROFORESTRY IN GHANA

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ASSESSING THE ECONOMIC PERFORMANCE OF COCOA AGROFORESTRY IN GHANA

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**DECLARATION**

I hereby declare that this submission is my own work towards the award of Master of Philosophy in Agricultural Economics. That, to the best of my knowledge, it contains no material previously published by another person or material which has been accepted for the award of any other degree in any University, except where due acknowledgement has been made in the text:

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## DEDICATION

This work is dedicated to my lovely husband, Mr. Simon Adu and daughter, Elizabeth Peletza Adu

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What shall I render to my God for this entire mercies store; I will take the gifts He has bestowed on me and humbly ask for more.

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# ABSTRACT

In Ghana cocoa occupies a key position in terms of foreign exchange earnings and domestic incomes, as well as being the major source of revenue for the provision of socio-economic infrastructure. Agroforestry is an important category of agriculture that provides potential benefit to farmers, communities and society at large with a wide array of forest-related goods and services.

The main objective of the study was to assess the economic performance of cocoa agroforestry in Ghana. The analysis is expected to assess the relative attractiveness of the various shade levels to cocoa farmers as well as to the society. Research data were collected by the means of Focus Group Discussion, household structured interviews and in depth case study. Data were analyzed through quantitative economic methods and models.

The results of the present research indicated that the medium and low shade levels were financially viable whiles high shade level and full sun plantation were not profitable. However, to the society cocoa agroforestry production had a positive impact on the overall welfare of the society irrespective of the shade level. There also exist some barriers to the adoption and the motivation of existing cocoa agroforestry system in Ghana, including, inadequate education on; the benefits derived from the inclusion of shade trees in cocoa plantations, which species to plant and how to plant them, tenure ship and logging as well as compensation for destroyed crops are possible threats to the realization of the full benefit of the cocoa agroforestry system.

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ADB-Agricultural Development Bank

CBR- Cost Benefit Analysis

CFC- Community Forestry Committees

COCOBOD- Ghana Cocoa Board

ERR-Economic Rate of Return

FAO- Food and Agriculture Organisation

FOASTAT- Food and Agriculture Organisation Statistics

FOB-Free On Board

FRR-Financial Rate of Return

FSD- Forestry Services Division

ICCO- International Cocoa Organization

IRR-Internal Rate of Return

ISSER- Institute of Statistical Social and Economic Research

LEV- Land Expectation Value

LP-Linear Programming

MoFA-Ministry of Food and Agriculture

MTS- Modified Taungya System

NAP- National Agroforestry Policy

NPV- Net Present Ration

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

Cocoa is a tropical tree crop that grows best in shaded areas. In Ghana, agroforestry is an important land use pattern which has been practiced, particularly, by rural communities (Ofori et. al, 1990). The main feature of agroforestry in Ghana is the intercropping of trees and shrubs with crops to enhance the agricultural environment. This practice gained prominence in Ghana in 1986 with the establishment of the agroforestry unit at the Ministry of Food and Agriculture (MoFA). This was followed by the formulation of a National Agroforestry Policy (NAP). An important form of agroforestry in Ghana is Cocoa-agroforestry in which cocoa is intercropped with trees crops, food crops as well as timber trees. Cocoa-agroforestry is established as follows. During the clearing of land for farming, indigenous fruit trees, medicinal plants and timber trees species are deliberately retained for their economic value and to provide shade for the Cocoa plants. Food crops such as maize, plantain, cocoyam and cassava are also intercropped with cocoa. Intercropping with food crops is done to increase shade for the cocoa seedlings. The cocoa is left to develop as farmers harvest the seasonal and annual crops. The system is further enriched by planting additional tree crops such as mango (mangifera indica) avocado (persea americanum), cola (cola nitida.) orange (citrus semensis) and where appropriate, timber trees. As the cocoa trees and other components grow to maturity, the system evolves to a closed canopy of a multi strata system that resembles natural forest with most of the positive externalities (Gockowski and Sonwa, 2008).

Agroforestry is important to the economy as sales of cocoa beans have been one of the major foreign exchange earners to Ghana throughout the years. Agroforestry increases and sustains crop yield, and reduces soil fertilization requirement. The importance of cocoa agroforestry to the economy of Ghana cannot be over emphasized. Environmental benefits of agroforestry system includes reduction of light intensity, temperature and air movement, leaf litter from shade trees provides mulch and a supply of organic matter for the soil (supplement fertilizer application), influences relative humidity which indirectly affects photosynthesis, improve yield and pest and disease management (Rice and Greenberg., 2000), improvement in air quality, improvement of soil easiness for tillage, and improvement in soil water holding capacity (Lehmann and Joseph, 2009).

Cocoa provides income for the numerous farmers engaged in its cultivation and has resulted in the setting up and expansion of agro-based industries. At the individual/household level, cocoa production serves as the primary source of income for over six million people in the two countries, 23 per cent of Côte d‟Ivoire‟s population and 11 per cent of Ghana‟s. With cocoa producers accounting for large population shares, leaders in both countries have used policies governing cocoa production for political gain in the past. For example, Côte d‟Ivoire‟s long-time president, Felix Houphouet-Boigny (1960–1993), blatantly used cocoa price support schemes to ensure his popularity among rural farmers (Losch, 2002). Cocoa funds have been ploughed back into the agricultural and non-agricultural sectors of the economy. Most important is investment in other ventures namely schools, roads, electricity generation and supply, water works development and health facilities to raise the standard of living of Ghanaians (ISSER, 2008). Cocoa production in Ghana over the years has experienced a decrease in its output leading to a decrease in the benefits derived by the economy. This has mainly been attributed to the removal of shade trees which results in a rapid depletion of soil nutrients and accounts for the shorter production cycles of cocoa trees. For cocoa to continue sustaining the economy and the farmers engaged in its cultivation, agroforestry systems must be introduced to help increase the output of cocoa and maintain sustainability of production of cocoa trees for farmers and the economy.

### 1.2 Problem Statement

In Ghana cocoa occupies a key position in terms of foreign exchange earnings and domestic incomes, as well as being the major source of revenue for the provision of socio-economic infrastructure (ISSER, 2008). Research has shown that, cocoa trees have shorter life cycles. This has resulted in a decrease in the foreign exchange earnings for the economy. This has been attributed to factors including the complete removal of shade from cocoa plantations which affects relative humidity, pest and disease management and photosynthesis which indirectly affects yield (Padi and Owusu, 1998, *cf. Asare, 2005*).

There is therefore an urgent need for research to actively develop models for incorporating desirable and fast growing trees, firmly in the cocoa growing system. This will help contribute to the rehabilitation of cocoa farms in the corridor of cocoa growing areas. The consequence of this will be a well-developed sustainable Farming system, which may prolong and increase farm yields (Ruf and Zadi, 1998). There is therefore a need to know the level of shade, which a farmer can adopt in order to help increase the output of cocoa and maintain sustainability of production over farmers‟ lifetime. Economic performance of the various levels of shade adopted for cocoa agro forestry is therefore necessary to determine their attractiveness to small holder farmers in the cocoa industry and the economy as a whole.

### 1.3 Research Questions

1. What are the inputs at the various cocoa agro forestry shade levels?

2. What is the output of cocoa from the various cocoa agro forestry shade levels?
3. What is the financial viability of the various cocoa agro forestry shade levels?
4. What is the economic viability of the various cocoa agro forestry shade levels?
5. What are the constraints associated with cocoa agroforestry production?
6. What are the social and environmental benefits associated with cocoa agroforestry production?

### 1.4 Objectives of the Study

The main objective of the study is to analyze the economic performance of cocoa agroforestry in Ghana. The specific objectives are as follows:

1. To determine the demographic characteristics of cocoa agroforestry farmers in the study area
2. To identify the inputs required for the various cocoa agro forestry shade levels
3. To determine the yield or output of cocoa from the various cocoa agro forestry shade levels
4. To generate one hectare budget for the various cocoa agro forestry shade levels
5. To estimate the partial budget, internal rate of return (IRR) and the net present value (NPV) for the various cocoa agro forestry shade levels so as to determine the viability of each shade level
6. To value inputs and output at their opportunity cost to determine the economic viability of each shade level
7. To find out some constraints associated with cocoa agroforestry production
8. To find out the social and environmental benefits associated with cocoa agroforestry production

### 1.5 Justification of the Study

The West African sub region is host to the world‟s main cocoa producing countries, including Côte d‟Ivoire, Ghana, Cameroon and Nigeria. These countries are also undergoing major deforestation processes through progressive conversion of forests into cocoa fields (Ruf and Zadi, 1998). The main cocoa producing region in Ghana is presently the western region, which stands for more than 50% of total annual production of cocoa (COCOBOD, 2000).

Production is on the increase in the west due to farmers migrating from the traditional cocoa growing areas in Eastern, Ashanti, Brong Ahafo, Volta and Central regions. These areas are in many places denuded and have been abandoned. Re-establishing cocoa in these areas has proven difficult due to low soil fertility and inappropriate vegetation cover to provide shade for the young cocoa. There is therefore an urgent need for research to actively develop models for incorporating desirable and fast growing trees, firmly in the cocoa growing system. This will help promote biodiversity conservation and also contribute to the rehabilitation of cocoa farms in the corridor of cocoa growing areas. The consequence of this will be a well-developed sustainable Farming system, which may prolong Farm yields and reduce the migration of farmers to new forest corridors.

**1.6 Organization of the Study**

This work was divided into five chapters; the first chapter deals with the general background, and justification of study. Literature, relevant to this research was reviewed in chapter two. The methodology and area of study make up the chapter three. It briefly describes the study area, and the procedure followed in the analysis of this study. Chapter four discusses the results of the study and chapter five deals with the conclusions, recommendations and limitations of the study and suggestions for future research.

## CHAPTER TWO

## LITERATURE REVIEW

This chapter provides a review of the relevant literature to the study. This is grouped under four sections. Section one talks about agroforestry in cocoa plantations, Section two discusses the role of shade trees in cocoa production, Section three discusses the long-term sustainability of the cocoa production and Section four also talks about the economic analysis of adoption and agroforestry systems.

## 2.1 Agroforestry in cocoa plantations

Agroforestry is the management system according to which perennials trees are cultivated in community with either crops and/or livestock. The cocoa tree (Theobroma cacao L.) naturally grows in a forest community in humid tropical areas under shaded conditions (ICCO (2014). Thus the approach of growing cocoa as a cash crop in a community with other tree species and other cash crops can be seen as a reconsideration of the natural habitat of the cocoa tree. By regularly pruning interventions in the plantations, this change in light inflow can be supported and regulated. The branches and leafs falling on the ground in follow of pruning are decomposed by microbial activities and end up in organic matter, continuously restoring the soil condition (FiBL et al.(2002)), this can diminish the need of fertilizer. In the first phase, the pioneer species (this could be food crops) cover the ground, this plants though have only short life time spans, afterward they make space to the fast growing tree species with different life cycles, this secondary phase represent the secondary forest condition. Food and cash crops are harvested continuously and by this occasion pointed pruning and weeding can refresh the ecosystem and make place for new niches, assuring a constant dynamic in the system (FiBL et al.(2002)). An agroforestry plantation can be established either on existing plantations or on areas cleared before. When looking at the case of an existing plantation, old and unproductive cocoa plants have to be selected and either removed or heavily pruned, so that new micro-ecosystem can establish in the resulting space, then food crops and other tree species are sown simultaneously. For the cocoa plants it is recommended to use seedlings and to plant them after the other species have already sprout. Otherwise, in the before cleared area the cocoa can be sown together with the other species (FiBL et al. (2002)). The agroforestry approach is seen as a valuable method to improve the sustainability of tropical agriculture, which on one side is an important economic pillar of many tropical regions, and on the other side a main cause for deforestation of tropical forests and for biodiversity losses (Sakanashi (2010)).

In order to provide shade to young cocoa plants, banana/plantain is widespread grown with cocoa and possibly introduced beforehand (Sonwa *et al.*, 2009). Farmers retain and/or introduce other trees either exotic and/or native species to create a long lasting canopy and to satisfy other needs of the household (Sonwa, 2004; Sonwa and Weise, 2008). This composition made of a mixture of cocoa, native forest trees and/or exotic trees, leads into a multi-strata and multispecies system with a structure and function similar to forest (FAO, 2002; Sonwa *et al.*, 2008). Asare *et al.* (2009) also report on farmers retaining and planting trees with different shade levels as a practice to reduce temperature, wind speed, evaporation and direct sunlight exposure, as well as to intercept rain, thus influencing the local microclimate. Aiming at establishing both a temporary and a permanent shade effectively covering cocoa, young cocoa trees (between 0-3 years) should benefit of shade levels of about 70% (30% sunlight) while mature and old cocoa trees (i.e. 4 years and beyond) would need about 30-40% shade (70% sunlight, as suggested by Asare and Sonii, 2010). Eventually, the smallholders‟ selection of neighbour trees to be planted in their cocoa fields is based on their intrinsic value, mainly in terms of additional income and family consumption (Sonwa, 2004). Frequently, understory food crops and upper canopy trees are established on cocoa farms for consumption, additional income, minimization of risk through diversification, and provision of shade for cocoa plants (Isaac *et al*., 2007). Hence, integration of crop production and upper canopy trees are management options during farm development (Duguma *et al*., 2001). The maintenance of agro forestry diversity remains a top ecological and economic priority for farm sustainability as well as improves farm potential for adaptability to changing conditions. As the farmers‟ goal is for the most part profitability, advancement of economic diversification also takes precedence (Asare, 2005). However, recent pressure in the Western Region of Ghana for higher cocoa production, reductions in available land and increased access to inorganic fertilizers have resulted in the removal of upper canopy and food crop species (Boni *et al*, 2004), presumably affecting overall species richness.

While research is focusing on trees in cocoa systems, opinions differ in the various countries on optimal levels of shade and those trees that are compatible or incompatible with cocoa. For example, Ghana tends to focus on finding an appropriate balance of shade, and on identifying compatible tree species, whereas Côte d‟Ivoire focuses on limiting shade and identifying and disseminating information on species that are incompatible with cocoa. In Cameroon and Nigeria cocoa agroforests currently have high levels of shade, making research and development focused on reducing shade to a more productive level while maintaining important indigenous fruit trees. A second trend across all four countries is a focus on maintaining or increasing cocoa production, particularly in Cameroon and Nigeria where production has been relatively low. In Côte d‟Ivoire and Ghana maintaining or increasing production have required the rehabilitation of ageing cocoa farms and the recycling of land in response to the extensive deforestation and loss of traditional cocoa growing land. This strategy involves using exotic leguminous species and native forest species to reduce fallow lengths through soil fertility improvement and creating appropriate vegetation cover as initial shade for cocoa (Asare, 2005). Studies conducted in the critical conservation area of the Ecuadorean Chocó report on farmers increasingly believing that shade reduces yield, thus removing most shade trees from their fields (Waldron *et al.*, 2012). This situation is also supported by Ruf (2011), whose work revealed that under heavy shade cocoa yields and revenues are low, if compared to yields from a full sun mature cocoa farm.

Since the introduction of cocoa into Ghana in 1879 (COCOBOD, 2000), cocoa has become both economically as well as culturally significant to the country. Despite this fact, cocoa farming has been alleged to be one of the factors that have contributed to deforestation in Ghana. Traditionally, most cocoa farms are established by removing the forest understory and thinning the forest canopy so that cocoa seedling can grow into productive trees by utilising the „forest rent" of the newly cleared area and the shade provided by the remaining trees. Currently the Western Region remains the last frontier for the expansion of cocoa due to the presence of patches of non-reserved and reserved forest in the country. Many farms in the other cocoa growing areas are denuded and have been abandoned (Ministry of Finance, 1999). The government and associated national and international research institutes are promoting agroforestry technologies that facilitate rehabilitation of old farms and recycling of degraded lands in order to solve this problem. The management of complex agro forestry systems is largely dependent on the optimization of both ecological and social processes. Specifically, for cocoa (*Theobroma cacao* L.) agroforestry in Ghana under conditions of low soil fertility and constraints to fertilizer access, farmers frequently develop techniques to promote soil and crop nutrition, as well as maintain shade for healthy plants (Boni et al. 2004). Upper canopy trees are retained or planted to regulate light and they consequently increase farm diversity and enhance biomass inputs, improving soil fertility and plant nutrition (Isaac et al. 2007).

### 2.2 Role of shade trees in cocoa production

The establishment of an agroforestry system has influence on pest and disease pressure, but the interactions are very specific and complex. On the one hand the monitoring of pest and disease in agroforestry is much more difficult than in a monoculture plantation, and also harder to manage, but on the other hand the system is more resilient and self-regulating. In the ideal case, an agroforestry system is able to reduce the pest and disease risk, otherwise a poorly designed system can also increase the sensitivity of single crops versus pests and diseases, for example due to enhanced stress because of light competition with other plants and so lower resistance versus pests and diseases. So the resilience of agroforestry systems highly depends on the design, and thus on overall knowledge about the ecosystem (Schroth et al. (2000)).

Agroforestry is also seen as a promoter of biodiversity richness, since a variety of species find profitable habitats within this system (Bisseleua et al. (2009)), a fact, that in periods of increasing concerns about biodiversity, additionally increase the interest in this system. Due to the variety of plants within an agroforestry cocoa plantation, it becomes possible to diversify the yields and so the income sources of the farmers. Even if they do not sell all staple crops on the market but consume a part of them as subsistence crops, they can anyway save money. An income diversification for smallholders is moreover always a risk reducing aspect (e.g. from price shocks or yield failures). Another favorable aspect of agroforestry lies in the carbon sinking potential of the system. In a review paper, Albrecht & Kandji (2003) found several studies indicating that an inclusion of trees in different agricultural systems is likely to improve the carbon storing capacity of these systems. Certainly the amount of carbon stored depends heavily on the specific system site and design; however agroforestry can be seen as promising approach to encounter problems related to greenhouse gas emission in agriculture (Albrecht & Kandji (2003)). Agroforestry systems show promising benefits not only regarding climate change mitigation but also regarding the adaptation to this climate changes. In fact agroforestry systems can on one hand increase the resilience of small hold farmers (due to a income diversification) and on the other hand help to absorb negative effects rising from weather variabilities due to climate changes. As example the deeper root systems of agroforestry plantations can help to better provide the vegetation with water and nutrients during droughts, or the increased soil cover and porosity can enhance the water balance of the soils (Verchot et al. (2007)). Regarding the cocoa yields in agroforestry plantations compared with traditional monocutlures, different results are reported; Gockowski et al. (2013) compared the yields of a shaded cocoa plantation under a Rainforest Alliance certification (RA) with a plantation grown under full sun and intensive conditions and found that the RA certified cocoa yield reached 78% of the yield harvested in the full sun system. Other studies indicate that there is no relationship between species richness and cocoa yield in agroforestry systems (Bisseleua et al. (2009)), indicating that a well designed agroforestry can result in a good productivity. The system can be highly dynamic and complex. Cocoa is traditionally cultivated in agroforestry systems around the world (Almeida & Valle (2008)) and there is a lot of experience with it. In western Africa, the mostly used cropping method is noshaded cultivation but in recent time, efforts are undertaken to foster agroforestry also in this region (Asare (2005); Gyau et al. (2014)).

**2.3 Long-term sustainability of cocoa production**

As the cultivation of cocoa has been an important driver of tropical deforestation, efforts to reverse this trend are focusing on the reintroduction of shade trees to cocoa plantations, since shade trees can enhance biophysical conditions on cocoa fields and contribute to biodiversity and product diversification for smallholder producers; (Obiri *et al.*, 2007). A study by Obiri *et al.* (2007)

compares hybrid, shaded hybrid and traditional cocoa and found that, from an economic perspective, cocoa production will remain, in general, profitable, even in case of a 20% reduction in cocoa price or yield. Over a period of an 80 years cycle, the shaded hybrid has generated the highest net cash flow but, as acknowledged by the authors, such long period is unrealistic. Moreover, as trials on hybrid cocoa have not yet been studied over the long period, their high yields sustainability is unknown.

In addition to the greater vigour of the hybrid, the use of moderate amounts of pesticides, fertilizers and herbicides (as experimented, in the same chronological order, in Ghana and Côte d„Ivoire) helps in preserving relatively good yields and good incomes in 25-30 year old unshaded cocoa farms (Ruf, 2011). On the other hand, according to the author, biodiversity-friendly incentives may push farmers into using unsustainably high levels of shade (e.g., if yield losses exceed price premium gains in certification schemes). As a consequence, economically precarious cocoa farms are often abandoned and replaced by more profitable but biodiversitypoor monocultures (such as oil palm).

**2.4 Economic analysis of adoption of Agroforestry systems**

The economic performance of agroforestry approaches is a bright study area and many different approaches offer themselves as analysis tool. The most widely used methods base on the cash flow analysis, used to estimate the net present value (NPV), the cost-benefits ratio (CBR), the internal rate of return (IRR) or the land expectation value (LEV) (Gockowski & Sonwa (2011); Obiri et al. (2007); Manivong & Cramb (2008)). Another assessment approach of the economic performance is simulation models and mathematical programming. Those approaches can be very helpful when comparing different scenarios and are thus widely used in making policy recommendations. But often such approaches demand for big computing effort and knowledge. A simple but promising method is the Linear Programming (LP) approach. The aim of this method is to detect the most efficient resource allocation given a certain set of restriction, so that an objective function can by maximized (or minimized). Surely the LP approach faces different limitations, but in agricultural planning it represents a widely used tool given its simplicity.

The aim of economic analysis of projects is to identify and select public investments that sustainably improve the welfare of beneficiaries. The analysis begins at project identification, during country strategy studies and programming, and continues iteratively throughout the project cycle (ADB, 2005). The economic aspect of project preparation and analysis as noted by Gittinger (1984) and ADB (2005) require that the proposed project contributes significantly to the development of the economy and must also justify why scarce resources should be put into it. In economic analysis taxes and subsidies are treated as transfer payments. Subsidy is an expenditure the economy incurs on resources used on the project but taxes are benefits to the society as they are payments into the government treasury. If a project is not financially sustainable, economic benefit will not be realized, so financial and economic analyses are complementary (ADB, 2005). Economic analyses of projects also involve the estimation of opportunity costs of the outputs and inputs of the project. Economic costs and benefits are calculated as the ratio of the shadow price of a project item, or the resources that go into it, to its market price. The effect of estimated ratios on project worth should be investigated through sensitivity analysis because simple estimates of the shadow exchange rate factor take into account only the tax and subsidy system and not other factors which separate financial and economic prices, such as monopoly rents (ADB, 2002).

### 2.4.1 Economic Viability

Economic viability depends on the sustainability of project effects. Projects are sustainable if their net benefits or positive effects endure as expected throughout the life of the project (ADB, 2005). Sustainability is enhanced if environmental effects are internalized, and if financial returns provide an adequate incentive for project-related producers and consumers. Sustainable development is concerned also with distributional issues. When looking at the distribution of project effects and judging project social acceptability, it is important to determine who benefits and who pays the costs (ADB, 2005). Also given the same level of technology a project will be more socially viable compared to its financial viability this is because where there is unemployment and social pressure for higher wages, the market price of labour is generally higher than its scarcity value (Gittinger, 1982).

### 2.4.2 Opportunity Cost

The benefit forgone for not using a resource in its best alternative use is referred to as its opportunity cost. Opportunity cost measured at economic prices is the appropriate value to use in project economic analysis for valuing non incremental outputs and incremental inputs (ADB, 2005). Opportunity cost as noted by Gittinger (1982) is the benefit forgone by using a scarce resource for one purpose instead of its next best alternative use. In a perfectly competitive market where there are many buyers and sellers with perfect information, the market price will be equal to the marginal value product of an item. In that case, the market price, opportunity cost and the marginal value product will be equal. The net benefit or profit of any enterprise will be maximized when the use of and input adjusted to the point where its marginal value product is equal to its opportunity cost (Gittinger, 1984 and ADB, 2005).

In financial analysis the opportunity cost of a purchased input is the same as the market price but economic analysis the opportunity cost of a purchased input is equal to the marginal value product in its best non-project alternative use. Related to the opportunity cost is the shadow exchange rate, official exchange rate and value-added. The shadow exchange rate is the economic price of foreign currency used in the economic valuation of goods and services. It is calculated as the weighted average of the demand price and the supply price for foreign or the ratio of the value of all goods in an economy at domestic market prices to the value of all goods in an economy at their border price equivalent values. Official exchange is the rate established by the monetary authorities of a country at which domestic currency may be exchanged for foreign currency (ADB, 2005). Where there are currency controls, the official exchange rate is taken to be the market rate. The official exchange rate is always used in financial analysis. If more than one official exchange rate exists, then the rates that apply should be used in financial analysis (Gittinger, 1984). Value –added on the other hand is defined as the difference between the gross value of output (quantity multiply by price) and the total cost of intermediate inputs. It represents the net amount available to distribute to the primary factors of production (Ellis, 1992). It is important to note that the shadow exchange rate is generally greater than the official exchange rate, indicating that domestic purchasers place a higher value on foreign currency resources than is given by the official exchange rate (ADB, 2004 and 2005).

## CHAPTER THREE

## METHODOLOGY OF THE STUDY

This chapter is presented in five sections. The first section provides a brief description of the cocoa agroforestry shade levels. The second section discusses the conceptual framework on financial and economic analysis. The third section states the hypotheses to be validated. Data collection is described in the forth section and finally methods used for the data analysis.

### 3.1. Description of Cocoa Agroforestry Shade Levels

In order to understand the viability of cocoa production under different shade levels, we develop for comparison, estimates of the returns to typical cocoa agroforestry production shade levels on the landscape. A total of 1 counterfactual and 3 hypothetical production systems were analyzed. A low, medium and high shade is compared with a no shade or full sun that is currently being promoted by COCOBOD. Cocoa pods are obtained and cultivated by the farmer in a nursery for 6 months for all productions. Of the 1,400, 1350, 1300, 1250 seedlings started for no, low, medium and high shade levels 1,100, 1080, 1040 and 1000 respectively are planted after rouging out the off types. This is due to the fact that shade trees occupy some planting spaces. An 80% seedling survival rate requires an additional nursery effort of 280 seedlings for replacement in the second year. Crops used by farmers as temporary shade at the early stages of cocoa establishment commonly include plantain among other crops. The production cycle for all levels was 30 years.

### 3.1.1 Low, Medium and High Cocoa Agroforestry Shade Levels

Costs and returns are estimated for 1 ha of cocoa planted at 3 x 3m spacing (approximately 1,080, 1040 and 1000 plants/ha for low, medium and high shade levels respectively) with permanent shade provided by a secondary forest of an average of 8, 15 and 25 indigenous trees for low, medium and high shade levels respectively in the study area. The dominant trees in the study area included *Terminalia superba* (Ofram), *Terminalia ivorensis* (Emire), *Milicia excels/regia* (Odum) and *Khaya ivorensis* (African mahogany). Cocoa is planted under the temporary shade canopy provided by plantains planted at a density of 1,600 per ha. A low shade cocoa agro forestry level comprises of 1-3 trees per acre (i.e. 3-8 trees per hectare), a medium shade cocoa agro forestry level comprises of 4-7 trees per acre (i.e. 10-18 trees per hectare) and a high shade cocoa agro forestry level comprises of 8 or more trees per acre (i.e. 20 or more trees per hectare)

### 3.1.2 No Shade or Full Sun Cocoa Plantation

Costs and returns are estimated for 1 ha of cocoa planted at 3 x 3 m spacing (1,100 plants/ha) with no permanent shade. Cocoa is planted under the temporary shade canopy provided by plantains planted at a density of 1,600 per ha.

### 3.1.3 Full Sun System and Agroforestry system

The Full sun system and agroforestry shade levels have commonalities and differences. There are specific activities and specific benefits and shortfalls (disadvantages) associated with each system. The full sun system is very easy and fast but affects the microclimate which affects disease and pest incidence and photosynthesis.

Environmental benefits of agroforestry system includes reduction of light intensity, temperature and air movement, leaf litter from shade trees provides mulch and a supply of organic matter for the soil (supplement fertilizer application), influences relative humidity which indirectly affects photosynthesis, improve yield and pest and disease management (Rice and Greenberg., 2000), improvement in air quality, improvement of soil easiness for tillage, and improvement in soil water holding capacity (Lehmann and Joseph, 2009). Agroforestry also increases and sustains crop yield, and reduces soil fertilization requirement. However, the same system poses a threat which could be detrimental to crop yield if the appropriate number of trees are not incorporated.

### 3.2. Conceptual framework on financial analyses

Financial analysis carried out mostly at the farm level in agricultural projects attempts to measure the financial viability of the project and is a necessary complement to the economic analysis in decisions to undertake the project. A project may have several different beneficiary and participating agencies and since it may impinge different on each one its financial impact should be assessed separately for each.

### 3.2.1 Investment appraisal techniques adopted

In the feasibility analysis partial budget was employed for the short term profitability analysis and two main economics tools; namely Net Present Value (NPV) and Internal Rate of Return (IRR) were also employed for the long term profitability analysis.

**Partial budget**

Change in farm net income from the change to low, medium and high cocoa agroforestry shade levels from the full sun cocoa plantation for short-term agricultural decision was explored through the partial budget analysis.

Change in net income was calculated as:

$\Delta NI_{ca} = [RC_{inf} + AB_{yca}] - [AC_{yca} + RB_{inf}]$

Where:

$\Delta NI_{cs}$= Change in net income by switching from the full sun cocoa plantation practice to a cocoa agroforestry practice

$RC_{inf}$ = Reduced costs under the full sun cocoa plantation practice

$AB_{yca}$ =Additional benefits under a cocoa agroforestry practice

$AC_{yca}$ = Additional cost under a cocoa agroforestry practice

$RB_{inf}$ = Reduced costs under the full sun cocoa plantation practice

Since some of the inputs are the same for the full sun plantation practice and a cocoa agroforestry type, they are cancelled out so that only the items that vary across are captured in this calculation. Details of the items that vary across a full sun cocoa plantation and a cocoa agroforestry type, considered in this calculation can be seen in appendix C

**Net Present Value (NPV)**

Net present value is the present worth of the cash flow stream at a chosen discount rate. That is; NPV = present worth of benefit – present worth of cost.

Net present worth = $$\sum_{i=1}^{n} \frac{(B_t - C_t)}{(1+i)^t}$$

Where Bt = benefit per ha in each year; Ct = cost of production per ha in each year, t = 1, 2, 3...n, n = number of years, i = interest rate

The formal selection criterion for the net present value is to accept investments with net present value greater than zero. However, if the net present value works out to be negative, then we have a case in which, at the chosen discount rate, the present worth of the income or benefit stream is less than the present value of the cost stream. Hence the revenues are insufficient to allow for the recovery of the investment. An investment is technically and economically feasible if the net present value is positive.

**The Internal Rate of Return (IRR)**

Internal rate of return (IRR) represent the average earning power of the money or funds invested in the project over the life of the project. The IRR determines the discount rate that makes the net present worth of the incremental net benefit stream or incremental cash flow equal zero. It represents the maximum interest that a project could pay for the resources used if the project is to recover its investment and operating costs and still break even (Gittinger, 1982).

The decision rule when using the IRR measure of project worth is to accept all projects having an IRR equal or above the opportunity cost of capital. Projects are ranked in order of the value of the IRR. The rule for interpolating the value of the internal rate of return lying between discount rates too high on the one side and too low on the other is

$$IRR = LDR + DDR\left(\frac{PCL}{A}\right)$$

Where IRR= internal rate of return, LDR= lower discount rate, DDR= difference between the discount rates, PCL= present worth of cash flow at the lower discount rate, A= absolute difference between the present worth of cash flow at the two discount rates

Internal rate of return is that discount rate i such that

$$\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0$$

Where $B_t$= benefits in each year, $C_t$= costs in each year, t = 1, 2, 3…n, n= number of years, i = interest (discount) rate.

### 3.2.2. Preparation of a Hectare Budget

A budget is a financial document used to project future income and expenses. The budgeting process may be carried out by individuals or by companies to estimate whether the person/company can continue to operate with its projected income and expenses.

The budget has two functions. First, it estimates, as realistically as possible, the cost of completing the objectives identified in the project. The sponsor will use the budget details to determine whether the project is economically feasible and realistic. Secondly, the budget provides a means to monitor the project's financial activities over the life of the project. In this way, it's possible to determine how closely the actual progress toward achieving the project objectives is being made relative to the proposed budget (Wagonhurst, 2005).

In preparing a budget one need to consider the expected revenue and the assumed cost. The expected revenue is normally expressed by multiplying the quantity of the product by the price.

The cost of production is also divided into; variable and fixed cost. A variable cost is a cost that varies, in total, in direct proportion to changes in the level of activity. The activity can be expressed in many ways, such as units produced, units sold, miles driven, beds occupied, hours worked and so forth. Direct material is a good example of variable cost. A fixed cost is a cost that remains constant, in total, regardless of changes in the level of activity. Unlike variable costs, fixed costs are not affected by changes in activity. Consequently, as the activity level rises and falls, the fixed costs remain constant in total amount unless influenced by some outside forces, such as price changes. Rent is a good example of fixed cost. Examples of fixed cost include straight line depreciation, insurance property taxes, rent, supervisory salary, cost of machines and other equipment, etc. (Garrison, 1999).

### 3.3. Conceptual framework on Economic Analyses

The principal idea of the study is that trees in the cocoa growing systems contribute to: sustaining production of cocoa, reducing risks of fire hazards, diversification of the total farm output, buffer and take pressure away from remaining natural forest, conservation of biological diversity yielding a tremendous savings in cost and this improves smallholder farm income. Agroforestry introduces additional cost to farmers and this could be offset by the gains in yield, fertilizer, insecticides and fungicides application forgone. Given the various shade levels in cocoa agroforestry, farmers in Ghana will choose the system that pays them much. They will choose the option that costs them less and pays them more. For this research, $1 equals GH¢2.85 and the interest rate is 18%. Average cost of capital in the domestic economy is 30%.

Agroforestry system is assumed to be viable on the basis that a farmer‟s decision to change to a new technology depends on the relative profitability of the technology (Horton, 1982).

#### 3.3.1 Shadow Pricing Of Inputs and Outputs

Once financial prices or costs and benefits have been determined and entered in the project accounts, the analyst estimates the economic value of a proposed project to the nation as a whole. The financial prices are the starting point for the economic analysis; they are adjusted as needed to reflect the value to the society as a whole of both the inputs and outputs of the project. This was achieved by valuing inputs and outputs to reflect their scarcity values. In evaluating social profitability of cocoa agroforestry**,** financial analysis is converted to economic analysis by valuing inputs and outputs at their opportunity cost. In the process, the financial accounts were converted to economic accounts by converting market prices to shadow prices so to reflect their opportunity cost or the scarcity value. In doing so, the approach of Gittinger (1982) was extensively used.

Where there is unemployment and social pressure for higher wages in developing countries, the market price of agricultural labour is generally higher than its scarcity value (Gittinger, 1982). Here the budget used assumed that the opportunity cost of unskilled labour (farm labour) is 50% of the market wage and further reduced by a standard conversion factor. The conversion factor used here is 0.855, calculated from the official exchange rate. The opportunity cost of labour could be calculated by estimating the total person hours required for the project in the peak season and multiplying that by the wage rate in the area for the peak season and reduced further by the conversion factor. The peak season is the season when everybody can find work to do. At that period, the opportunity cost of labour could be equal to the marginal productivity of labour. In a labour-abundant society where everybody finds work at a good price in peak seasons like planting and harvesting time, we could accept the market wage as a good estimate of the opportunity cost. The price of labour in a perfectly competitive market could be determined by its marginal value product (the value of the additional product that any additional labourer employed on the farm could produce). But in most cases, marginal productivity of agricultural labour is close to zero Gittinger (1982). Hence our approach offers a good valuation of labour at its scarcity value.

**Conversion factor** = Interest rate x Official exchange rate (GH₵/US$)

**Shadow price of labour inputs** = 50% of Market price x Conversion factor

Where taxes and subsidies are paid from one part of the society to another, their effect on market prices should be removed to get economic prices (Gittinger, 1982). The economic value of other inputs was attained by multiplying the market price by the conversion factor of 0.855. The shadow pricing reduces the market prices to allow for possible changes in the market prices due to the exchange rate. The current market price of fertilizer is a subsidized one (under 30% subsidy), the full cost being GHc 1.57/kg. Since subsidy is a transfer payment from one sector of the economy to another, it is restored in the economic account because it is not considered as a benefit. Again, the subsidy on fertilizer operates to reduce the cost of the input and hence restored in the economic account. The shadow price of fertilizer is derived by multiplying the market price obtained upon restoration of subsidy by the standard conversion factor. That is the shadow price of fertilizer per kg is GH₵ 1.34. Since land is mostly not purchased out-rightly by farmers for production, the opportunity cost of land was obtained by multiplying the rental value by the conversion factor:

**Shadow price of other inputs** = Market price x Conversion factor

Table 3.1 Input parameters for the financial and economic analysis

| Parameters | Financial analysis | Economic analysis |
|---|---|---|
| Interest rate | 30% | 18% |
| Price of inputs and equipment | Market price | Market price x conversion factor |
| Price of labour inputs | Market price | 50% of Market price x Conversion factor |
| Conversion factor | Interest rate x Official exchange rate (GH₵/US$) | |
| Official exchange rate | $ US 1= GH₵ 2.85 | |

Source: Author

Outputs considered were cocoa, shade trees and temporary shade crops per hectare for the three study areas considered. Table 3.2 summarizes the computation of the border equivalent farm gate price of exported cocoa valued at the official exchange rate. Since cocoa is a tradable commodity the economic value of cocoa was its border price (in this case the FOB) adjusted to reflect domestic charges (FOB of cocoa ($2700)).

Table 3.2 Economic Adjustment Of International Price of Cocoa to Border Equivalent Farm Gate Price

| Item | GH₵ |
|---|---|
| Export price f.o.b ($/t) | 2700 |
| *Official exchange rate $ US 1= GH₵ 2.85 | |

| | |
|---|---|
| =Export price f.o.b (US equivalent/ GH₵) | 7695 |
| -Handling cost, border to warehouse (1%) | 76.95 |
| -Processing and transport, farm gate to ware house (2%) | 153.9 |
| -Port fees and charges (30%) | 2308.5 |
| =Border equivalent farm gate price/t GH₵ equivalent (official exchange rate) | 5155.65 |

Source: author

### 3.3.2 Measuring Financial and Economic Viabilities

The viability of cocoa agroforestry production under the various shade levels was measured using cost-benefit tools which measure viability from two differing perspectives. Firstly the inherent financial profitability of cocoa agroforestry under the various shade levels for was measured, to determine whether there is a financial incentive for resource users to invest in the activity. The financial analysis provided an estimate of the financial internal rate of return over thirty year life of the cocoa agroforestry plantation and the financial net present value over thirty years, in terms of the prevailing prices in the market place. Secondly the economic value of cocoa agroforestry under the various shade levels was measured, to determine whether the activities contributed to the overall welfare of society and the nation. Economic analysis focuses attention on the profitability of the project to the whole society or economy of all the resources committed to the project regardless of contributions and beneficiaries. This determines the net contribution of cocoa agroforestry to the national economy in terms of national income. The economic analysis provided an estimate of the economic internal rate of return and the economic net present value both over thirty years. It involved use of prices which commonly differ from the financial ones referred to above. The values applied to inputs and outputs were those considered to reflect their real scarcity in society. They reflect the cost to society of resources being used in cocoa agroforestry and not in any other activities or sectors of the economy.

The process of conversion from financial to economic values in the cost-benefit analysis is termed shadow pricing. Since there were no general shadow pricing criteria for Ghana, the preliminary ones adopted by the Directorate of Environmental Affairs was used. These are adapted, to a large extent, from the approach of Gittinger (1982) and manuals developed for South Africa and Botswana. Where there is unemployment and social pressure for higher wages, the market price of labour is generally higher than its scarcity value. Where taxes and subsidies are paid from one part of the society to another, their effects on market prices should be removed to get economic prices. Input subsidies for cocoa production, which were once significant, have now been largely eliminated except that of fertilizer. Economic analysis, then, will state the cost and benefit to the society of the proposed project investment in opportunity cost. The difference between the benefit and the cost-the incremental net benefit stream is an accurate reflection of the project's income-generating capacity-that is, its net contribution to real national income (Gittinger, 1982).

In both financial and economic analysis, cost and benefit flows are discounted over time to reflect the time value of money. Since constant prices were used (inflation was excluded) the discount rate had to be in real terms. The private opportunity cost of capital provides a realistic discount rate for financial analysis. The opportunity cost of capital can also be used for economic valuation but here the long term cost of funds to the state is relevant. Generally high discount rates reflect scarcity of capital relative to investment opportunities and favour labour intensity over capital intensity. If the availability of capital in the private sector is such that its opportunity cost is lower than the long term real economic cost, then private sector expansion will tend to be encouraged more than public sector expansion.

The economic cost-benefit analysis for cocoa agroforestry levels excluded central government expenditures or investments in the agriculture sectors, indirectly affecting these activities. This is because these expenditures are extremely difficult to allocate correctly and also because it is conventional to treat the public sector separately in national income accounts. Most output modeled in this paper was for export and we were thus able to ignore any consumer surplus changes (since they would have affected non-nationals).

### 3.4 Hypotheses of the Study

**1.** As shade level for cocoa agroforestry increases, the financial viability of cocoa agroforestry decreases.

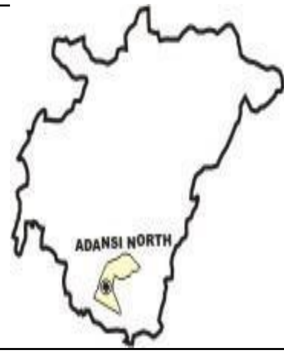
**2.** As shade level for cocoa agroforestry increases, the economic viability of cocoa agroforestry decreases.

### 3.5. Data Collection

#### 3.5.1 Study Area

The study was conducted in the Adansi North District, Ahafo Ano North District and Offinso Municipal all in the Ashanti region of Ghana. The following information was obtained from the website of the Ministry of Local Government and Rural Development in Accra at www.ghanadistricts.com.

**Table 3.3 Description of the Districts**

| District/ municipal | Adansi North | Ahafo-Ano North | Offinso South |
| --- | --- | --- | --- |
| Map |  |  |  |
| Location | Latitude: 6.30N<br>Longitude: 1.50W<br><br>Bounded by Bekwai Municipal (to the north), Adansi south (to the east), Amansie Central (to the west) and Oboasi Municipal (to the south).<br><br>Capital : Fomena | Latitude: 6˚ 47‟N and 7 02‟N<br>Longitude: 2˚ 26‟W and 2˚ 04‟W<br>North-west of Ashanti Region.<br><br>Bounded by Atwima District (to the south), Ahafo-Ano South District (to the east), and with Asutifi District (to the west) and Tano South District (to the north) in the Brong Ahafo Region of Ghana.<br><br>Capital: Tepa | Latitude: 6‟ 45N and 7‟ 25S<br>Longitude: 1‟65W and 1‟ 45E.<br>Extreme north-west of Ashanti Region.<br><br>Bordered by Ejura-Sekyeredumasi District (to the east), Afigya Sekyere Ahafo-Ano and Atwima District (to the South), Tano South (to the west) Techiman, Nkroransa all in Brong Ahafo region (to the north).<br><br>Capital: Offinso New Town |
| Size | About 1140 km$^2$, About 4.7% of Ashanti Region. | About 571 km$^2$ | About 1255km$^2$ |

| | | | |
|---|---|---|---|
| Geology | Tarkwain (pre Cambrian) and Upper Birimian rocks (mineral potentials). Granitic rock occurs at Akrokerri, Dompoase, Patakro and Kwapia. | The Birimian rock formation | Granite, Voltain Rocks and Lower Birimian Rocks. |
| Soil | Forest Ochrosols<br><br>Rich in humus content. | Fertile Soils: 90% covered by Susan Simple and Adjaso Hwidiem Association. 10% covered by Birim-Chichiwere Association along the Tano River. | Granite soils: Kumasi-Offinso Association, Boamang-Suko Association, Bekwai-Oda Association, Adujamso-Bechem Association. Porous-red and well drained. Voltain and Birimian Soil: Sand and clay |

| | | | |
|---|---|---|---|
| Topology and drainage | Undulating terrain<br>Elevation: with more than half the total area rising to an average height of about 300 meters above sea level. In general the district is located in a hilly area.<br><br>Major Streams: Bemin, Fum, Gyimi, Kyeabo, Ankafo, Adiembra, Asabri, Subine, Konwia, Kyekye,<br>Atraime. | Birimian (mineral deposits) and Dahomeyan formations. Elevation: 700-900 feet above sea level. Gently rolling landscape.<br><br>Major rivers: Tano, (dendrite flow pattern). | Undulating and low lying plains near NkenkaasuAfrancho.<br><br>Elevation: 600-1000 feet above sea level. |
| Climate | Semi-Equatorial climatic region<br>Mean monthly temperature: $26^0$C-$30^0$C.<br>Mean annual temperature: $27^0$C<br><br>Total annual rainfall: 1250 mm-1750mm.<br>Rainfall: Bi-annual. April to July (Major rains), September to December (Minor rains).<br><br>Relative humidity: 80% (rainy season) and 20% (dry season). | Wet-Equatorial zone.<br>Mean monthly temperature: $26^0$C( in August)-$30^0$C (in March).<br>Mean annual temperature: $26^0$C<br>Maximum temperature: $29^0$C in March and April before rains start.<br><br>Total annual rainfall: 1250mm- 1800mm Raining days 100-120 a year with 75% occurring in the major raining season. Rainfall: Biannual. April to July (Major rains), September to December (Minor rains).<br><br>Relative humidity: 75-80% (rainy season) 7072% (dry season). | Semi-Equatorial and tropical conventional climates.<br>Mean monthly temperature: $27^0$C<br>Mean annual temperature: $27^0$C<br><br>Total annual rainfall: 1500 mm in the north and 1700mm in the south.<br>Rainfall: Bi-annual. April to July (Major rains), September to December (Minor rains).<br><br>Relative humidity: 75-90% (rainy season) 70-72% (dry season). |
| Vegetation | Semi-deciduous forest. | Moist deciduous forest<br>. | F<br>o<br>ur<br>(4 |

| | | | |
|---|---|---|---|
| | ) Forest Two (2) Forest reserves: reserves: Fum Desiri in the south and headwaters, Adu Kofi Tinte in the north-east.<br>forest reserves, | | About 704.94 $km^2$ of land under forestory.<br><u>Eight (8) forest</u> |
| Moist semideciduous forest. | | | |
| | Dampayaw forest reserve and Kusa ranges.<br><br>Economic trees: Wawa, Sapele, Odum, Mahogany | Economic-trees: Sapele, Odum, Wawa and Cola | reserves: Afram headwaters, Afrensu-Borohoma, Asubina Mankrug, Asufu West & East Kwamisa and Opro River Forest Reserves.<br>Economic-trees: Odum, Wawa, Cedar, etc. |
| Agriculture | Employs about 77% of labour force.<br>Mainly cash and food crops production, livestock, poultry, fish farming and irrigation vegetable farming.<br><br>Crops: Cocoa, oil palm, citrus, coffee (around Bena), plantain, cocoyam, yam, rice, pineapples, ginger (at Old Ayaase) and vegetables such as pepper, tomatoes, garden eggs, etc. (around Akrokerri and Dadwen). | Crops: Cocoa, oil palm and food crops such as plantain, cassava, vegetables (tomatoes, garden eggs, okro etc.) and dry season vegetables | Crops: both tree fee, arable crops. Coc cashew, and plan among others. |

| | | | |
|---|---|---|---|
| Economic activities | Gold mining (Ashanti Goldfields) around Asokwa, Nyankomasu and Fumso Ketewa (diamond).<br>Sand winning (Fomena, Dompoase, Old Edubiase, Abadwum and Kwapia) for building and road construction.<br>Wood lots (Odum, Wawa, and Sapele) for export and domestic market.<br>Granite rocks for quarrying for building and road constructions. | Trading in food stuff like plantain, cassava, maize, vegetables at Tepa food market (weekly) | Stone quarrying in the south and extreme north.<br><br>Sand winning. |
| Population<br>71,952 (2000 Population and Housing Census). | About 92,834 people as at the year 2000 when the last census was conducted, with a growth rate of 2.6% per annum. | Annual growth rate of 2.96%.<br>The 2000 Population and Housing Census yielded the District a population head count of 138,190. Annual growth rate of 5%, | higher than the region‟s growth rate of 3.4% of interregional growth rate. |

### 3.5.2 Sampling Techniques

Purposive and simple random sampling techniques were used for the study. Ashanti region was purposively selected for the study because it is one of the main cocoa producing regions in Ghana. The purposive sampling technique was also used to select three district and three communities which have adopted different shade levels in cocoa agroforestry production. The communities for the various districts included Pewode, Kwansimwaa and Kokoben in the Adansi

North district, Akwasease, Dwaaho and Maaban in the Ahafo-Ano North district and Samproso, Abrakuma and Achiase in the Offinso Municipal. The simple random sampling technique was used to select 30 farmers from each community totaling 90 farmers from each district. A total of 270 cocoa farmers were sampled from the three districts. The simple random sampling procedure was used because it is the best way by which each cocoa agroforestry farmer in the selected communities could have an equal chance of selection and also gives an accurate generalization of results. However, the drawback is that the simple random sampling does not guarantee that the sampled drawn is a representation of the population since it does not include some of the sets of the population.

#### 3.5.3. Data collection

Both qualitative and quantitative primary data were collected by way of open-ended and closeended questions. Questionnaires were administered through personal interviews with the selected farmers. The interview was conducted in the twi local language by enumerators. An informal group discussion was held with the district managers and some cocoa extension officers from the selected communities prior to formal data collection. Data collection took place on October, 2014. Non-documented data was also collected through discussions and interviews with officials of cocoa extension division**,** published papers and Journals and other relevant materials.

### 3.6 Methods of Data Analysis

Both descriptive tools and investment appraisal techniques were used to analyze the field data. The identification of the inputs required for the various cocoa agro forestry shade levels were analyzed using descriptive statistics such as means and frequencies. To determine the yield or output of cocoa from the various cocoa agro forestry shade levels, descriptive statistics specifically means and frequencies were employed in the analysis. In generating hectare budgets for the various cocoa agro forestry types, the descriptive statistics such as the means and frequencies were used. The viability of various cocoa agro forestry types were determined using the partial budget, internal rate of return (IRR) and the net present value (NPV) approach of evaluating projects. To value inputs and output at their opportunity cost in order to determine the economic viability of each cocoa agroforestry type, shadow prices of inputs and outputs were determined after which the NPV and IRR were employed. The descriptive statistics such as the frequencies were further used to find out the constraints associated with cocoa agroforestry production, and the social and environmental benefits associated with cocoa agroforestry production.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

This section provides a discussion of the results obtained from field data analysis. It is presented in five sections. They are socio-economic characteristics of cocoa farmers, social and environmental benefits from cocoa agroforestry, short term profitability analysis of a change from full sun cocoa plantation practice to the various cocoa agroforestry levels, the long term profitability analysis (financial analysis of the various cocoa agroforestry shade levels and the economic analysis of the various cocoa agroforestry shade levels) and the constraints to cocoa agroforestry production in the study area.

## 4.1 Descriptive Analysis

### 4.1.1 Socio-Economic Characteristics of Cocoa Farmers

Personal and household characteristics of cocoa farmer‟s sampled included age, gender, formal education, marital status, household size and access to credit. It also deals with plot level characteristics including cocoa farm size, land tenure arrangements, age of cocoa farms and cocoa variety. Of the 270 farmers sampled 21.48% were practicing the low shade level, 48.89% farmers practiced the medium shade level, 23.33% farmers practiced the high shade level and

6.3% farmers were under the full sun plantation.

***Age Distribution***

Table 4.1 depicts that most of the farmers were 50 years and above. This is similar to what Amanor (1996) reported that over 60% of cocoa farmers are currently over 50 years old, and unwilling to take extra risk in investing in yield improvement strategies. Hence, cocoa cultivation is a low input venture undertaken on small farms using rudimentary technology with very little purchased input (Amanor, 1996). This also confirms what Adetunji *et al*. (2007) and Gray (2001) found that cocoa farmers in West African countries in general have an average age of 50 years and above. The increasing age of farmers imposes a constraint. As farmers become less able, the ability to contribute to communal labour sharing is diminished. The farmer"s age restricts his/her ability to carry out more demanding tasks he/she is confronted with, this leads to the choice of employing relatively expensive hired labour or simply doing less of the tasks (Anim-Kwapong and Frimpong, 2005).

**Table 4.1 Distribution of respondents by age**

| Age of farmers | Number of farmers | Percentage of farmers |
|---|---|---|
| 20-29 | 11 | 4.07 |
| 30-39 | 39 | 14.44 |
| 40-49 | 71 | 26.30 |
| 50-59 | 81 | 30 |
| 60-69 | 37 | 13.70 |
| 70-79 | 25 | 9.26 |
| 80-89 | 6 | 2.22 |

Source: Field survey, 2014

### *Gender of Farmers*

As indicated in table 4.2, about 62% of the smallholder farmers sampled was males. DansoAbbeam (2012) had a similar observation in his study of empirical analysis of productivity and resource-use-efficiency in Ghana‟s cocoa industry where majority of the respondents was males.

Codjoe (2013) also made similar observations in his study. This signifies that males dominate in cocoa farming as an occupational business in the study area. This may be attributed to the exertion of physical energy required in cocoa cultivation and may also be due to women‟s limited access to resources including land and credit (Adesina et al. 2002).

**Table 4.2 Gender Distribution of farmers interviewed under the various shade levels**

| Shade levels | Male | Female | Total |
|---|---|---|---|
| Low shade | 26 (9.63) | 32(11.85) | 58(21.48) |
| Medium shade | 86(31.85) | 46(17.04) | 132(48.89) |
| High shade | 45(16.67) | 18(6.67) | 63(23.33) |
| No shade | 10(3.70) | 7(2.59) | 17(6.30) |
| Total | 167 (62) | 103 (38) | |

Note: Figures in parentheses are percentages
Source: Field survey, 2014

### *Formal Educational Level of Farmers*

The study reveals that 67% of the sampled farmers had access to basic education whiles 1.1% had access to vocational/technical/commercial education (table 4. 3). Asante (2008) and DansoAbbeam (2012) made similar observations in the study of the adoption of MD2 variety in Ghana and the study of empirical analysis of productivity and resource-use-efficiency in Ghana‟s cocoa industry respectively. Codjoe (2013) also revealed in his studies that, the greatest percentage of the respondents had primary education. By implication, it is somewhat certain that these prevailing educational levels could affect farmers‟ knowledge and the way they look at new technologies because a bulk of them had just basic education.

**Table 4.3 Formal educational level of farmers under the various shade levels**

| Formal education | Shade levels | | | | Total |
|---|---|---|---|---|---|
| | Low | Medium | High | No | |
| None | 18(6.67) | 28(10.37) | 16(5.93) | 4(1.48) | 66 (24.44) |
| Basic | 34(12.59) | 97(35.93) | 41(15.19) | 8(2.96) | 180 (66.67) |
| Secondary | 5(1.85) | 4(1.48) | 3(1.11) | 3(1.11) | 15 (5.56) |
| Voc/tech. | 1(0.37) | - | - | 2(0.74) | 3 (1.11) |
| Tertiary | - | 3(1.11) | 3(1.11) | - | 6 (2.22) |
| Total | 58(21.48) | 132(48.89) | 63(23.33) | 17(6.30) | |

Note: Figures in parentheses are percentages
Source: Field survey, 2014

***Marital Status***

Out of the 270 farmers sampled, about 81% were married and 3% were separated (table 4.4). This finding is similar to what Codjoe (2013) and Danso-Abbeam (2012) revealed in their studies, where majority of the respondents were married. Since cocoa production is a labour intensive venture, the support of a large family is usually seen as an added advantage when farming. It is, therefore, not surprising that majority of farmers were married.

**Table 4.4 Marital status of farmers for the various shade levels**

| Marital Status | Shade levels | | | | Total |
|---|---|---|---|---|---|
| | Low | Medium | High | No | |
| Single | 8(2.96) | 12(4.44) | 7(2.59) | - | 27 (10) |
| Married | 43(15.93) | 111(41.11) | 53(19.63) | 12(4.44) | 219 (81.11) |
| Separated | 2(0.74) | 4(1.48) | - | 2(0.74) | 8 (2.96) |
| Divorced | 5(1.85) | 5(1.85) | 3(1.11) | 3(1.11) | 16 (5.93) |
| Total | 58(21.48) | 132(48.89) | 63(23.33) | 17(6.30) | |

Note: Figures in parentheses are percentages
Source: Field survey, 2014

***Household Size***

The study considered individuals who were 15 years and above. Table 4.5 depicts that, out of the 270 farmers, 40% had their household size ranging from 4-6 and 8.52% had their household size been 10 or more. This is in line with what Balogun (2011) observed where family size was high in the area with an average of about 6 persons per cocoa household.

**Table 4.5 Distribution of household size under the various shade levels**

| Household size above 15 years | Shade levels | | | | Total |
|---|---|---|---|---|---|
| | Low | Medium | High | No | |
| 1-3 | 26(9.63) | 49(18.15) | 24(8.89) | 5(1.85) | 104 (38.51) |
| 4-6 | 20(7.41) | 56(20.74) | 24(8.89) | 9(3.33) | 109 (40.37) |
| 7-9 | 6(2.22) | 16(5.93) | 10(3.70) | 2(0.74) | 34 (12.59) |
| >9 | 6(2.22) | 11(4.07) | 5(1.85) | 1(0.37) | 23 (8.52) |
| Total | 58(21.48) | 132(48.89) | 63(23.33) | 17(6.30) | |

Note: Figures in parentheses are percentages
Source: Field survey, 2014

***Access to Credit***

It can be observed that, 11% of the farmers had access to credit for their farming operations (table 4.6). Credit is said to be a major concern both to project implementation and to farmers and it is for this reason that Owusu (1993), cautioned that for project implementation to be very successful cash needs of farmers should be met.

**Table 4.6 Credit access by farmers under the various shade levels**

| Access to credit | Shade levels | | | | Total |
|---|---|---|---|---|---|
| | Low | Medium | High | No | |
| Yes | 7(2.59) | 16(5.93) | 6(2.22) | - | 29 (10.74) |
| No | 51(18.89) | 116(42.96) | 57(21.11) | 17(6.30) | 241 (89.26) |
| Total | 58(21.48) | 132(48.89) | 63(23.33) | 17(6.30) | |

Note: Figures in parentheses are percentages

Source: Field survey, 2014

***Farm Size***

About 60.4% of the farmers had their farm sizes ranging between 1-5 acres and about 4% operated farms 16 acres and above as illustrated in table 4.7. It has been observed that there is a minimum farm size which sustains farmer interest in cocoa farming and the requisite investment in labour and other resources for a viable economic enterprise (COCOBOD, 1998).

**Table 4.7 Farm size distribution under the various shade levels**

| Farm sizes | Shade levels | | | | Total |
|---|---|---|---|---|---|
| | Low | | High | No | |
| Medium | | | | | |
| 1-5 | 40(14.81) | 77(28.52) | 35(12.96) | 11(4.07) | 163 (60.37) |
| 6-10 | 13(4.81) | 40(14.81) | 18(6.67) | 4(1.48) | 75 (27.78) |
| 11-15 | 3(1.11) | 9(3.33) | 3(1.11) | 2(0.74) | 17 (6.30) |
| 16-20 | - | 2(0.74) | 3(1.11) | - | 5 (1.85) |
| 21-25 | 1(0.37) | - | 2(0.74) | - | 3 (1.11) |
| 26-30 | - | 2(0.74) | - | - | 2 (0.74) |
| 31-35 | 1(0.37) | 2(0.74) | 1(0.37) | - | 4 (1.48) |
| | - | - | 1(0.37) | - | |
| | 58(21.48) | 132(48.89) | 63(23.33) | 17(6.30) | |
| >35 | | | | | 1 (0.37) |
| Total | | | | | |

Note: Figures in parentheses are percentages

Source: Field survey, 2014

*Land Tenure Arrangements*

It can be observed that, about 62.2% of the farmers owned or use family lands for cocoa farming their farming lands and 37.8% practice sharecropping (table 4.8). This is in line with what Balogun (2011) revealed that Land was mainly acquired through inheritance (owned).

**Table 4.8 Land Tenure arrangement of farmers under the various shade levels**

| Land tenure arrangements | Shade levels Low | Medium | High | No | Total |
|---|---|---|---|---|---|
| Owned/ Family land | 50(18.52) | 72(26.67) | 32(11.85) | 14(5.19) | 168(62.22) |
| Share-cropping | 8(2.96) | 60(22.22) | 31(11.48) | 3(1.11) | 102 (37.78) |
| Total | 58(21.48) | 132(48.89) | 63(23.33) | 17(6.30) | |

Note: Figures in parentheses are percentages
Source: Field survey, 2014

*Age of Cocoa Trees*

29.3% of the farmers sampled had their cocoa trees older than 25 years as depicted in table 4.9. This is similar to what Amanor, 1996 found that about 25% of current cocoa-tree stocks are over 30 years old in his research on the managing of trees in the farming system.

**Table 4.9 Age of cocoa trees under the various shade levels**

| Age of cocoa trees | Shade levels Low | Medium | High | No | Total |
|---|---|---|---|---|---|
| 1-5 | 3(1.11) | 2(0.74) | 4(1.48) | 1(0.37) | 10 (3.70) |
| 6-10 | 12(4.44) | 32(11.85) | 10(3.70) | 2(0.74) | 56 (20.74) |
| 11-15 | 11(4.07) | 19(7.04) | 12(4.44) | 2(0.74) | 44 (16.30) |
| 16-20 | 12(4.44) | 34(12.59) | 12(4.44) | 4(1.48) | 62 (22.96) |
| 21-25 | 5(1.85) | 4(1.48) | 6(2.22) | 4(1.48) | 19 (7.04) |
| >25 | 15(5.56) | 41(15.19) | 19(7.04) | 4(1.48) | 79 (29.26) |
| Total | 58(21.48) | 132(48.89) | 63(23.33) | 17(6.30) | |

Note: Figures in parentheses are percentages
Source: Field survey, 2014

***Cocoa Varieties Grown***

20% farmers sampled grow local varieties, 43.7% grow hybrid varieties and 36.3% grow both hybrid and local (table 4.10).

**Table 4.10 Cocoa varieties under the various shade levels**

| Cocoa Variety | Shade levels | | | | Total |
|---|---|---|---|---|---|
| | Low | Medium | High | No | |
| Local | 15(5.56) | 31(11.48) | 5(1.85) | 3(1.11) | 54 (20) |
| Hybrid | 30(11.11) | 54(20) | 26(9.6) | 8(2.96) | 118 (43.70) |
| Both local and hybrid | 13(4.81) | 47(17.41) | 32(11.85) | 6(2.22) | 98 (36.30) |
| Total | 58(21.48) | 132(48.89) | 63(23.33) | 17(6.30) | |

Note: Figures in parentheses are percentages
Source: Field survey, 2014

**4.2 Social and environmental benefits from cocoa agroforestry**

Apart from revenue from cocoa and shade trees, other benefits of cocoa agroforestry include the intangible social and environmental benefits (table 4.11)

Majority (76.7%) of farmers considered sustainable yield as major social and environmental benefits of cocoa agroforestry. About 68.9% of the respondents indicated that cocoa agroforestry helps in soil fertility improvement, 24.4% considered cocoa agroforestry as a way of controlling erosion, 41.1% indicated that cocoa agroforestry provided multiple revenue, 47.8% considered weed control as a benefit obtained from cocoa agroforestry, 24.4% said it enriches biodiversity, and at least about 11% of the respondents indicated that cocoa agroforestry improves moisture, modifies the microclimate, helps in controlling mistletoe and serves as wind breaks. All these benefits can be considered as the positive but intangible benefits of the cocoa agroforestry which cannot be quantified in monetary terms. These are benefits that go to the whole society and not only the farmers. Aidoo (2009) had similar findings in his work on the economic analysis of the modified taungya system (MTS) in the transitional zone of Ashanti Region, Ghana. He indicated that, prevention of soil erosion and land degradation, prevention of desertification, preservation of water bodies, microclimate modification, reduction of bush fires and wind breaks were some of the social and environmental benefits of agroforestry.

**Table 4.11 Social and environmental benefits from cocoa agroforestry**

| Benefits | Yes (Frequency) | Percentage (%) |
|---|---|---|
| Sustainable yield | 207 | 76.7 |
| Soil fertility improvement | 186 | 68.9 |
| Erosion control | 66 | 24.4 |
| Multiple revenue | 111 | 41.1 |
| Weed control | 129 | 47.8 |
| Biodiversity enrichment | 66 | 24.4 |
| Improves moisture | 9 | 3.3 |
| Microclimate creation | 9 | 3.3 |
| Mistletoe control | 6 | 2.2 |
| Wind breaks | 6 | 2.2 |

Source: Field survey, 2014

### 4.3 Empirical Analysis

This is grouped under five sections. Section one discusses the output, cost and returns of the various shade levels, Sections two and three discusses the financial and economic viability of the various shade levels of cocoa agroforestry production respectively, Section four compares economic and financial viability of the various shade levels of cocoa agroforestry production and section five the constraints to cocoa agroforestry production in the study area.

### 4.3.1 Output, Cost and Returns of the Various Shade Levels

This section presents the analysis of output, cost and returns per hectare per annum involved in the various shade levels of cocoa agroforestry production**.** In the developing world, most farmers have to accept low yields as they are unable to consider the use of improved production methods, because they operate at small scale subsistence levels. Yield differences among different shade levels will draw farmers‟ attention to lost production potential under the prevailing climatic conditions in their respective environments and what production practices ( shade management, pest and disease control, pruning, fertilizer application, weed management, etc.) need to be improved. Yield differences among different shade levels adopted for cocoa agroforestry as shown in fig 4.1 below should provide the incentive to manoeuvre towards yield improvement. Crops used by farmers as temporary shade at the early stages of cocoa establishment commonly include plantain among other crops. These promote weed suppression and soil improvement. Plantain is normally used for the first three years and this generates revenue for the farmer. For the output of plantain, a bunch weight of 6kg will be expected in the first year, 7kg in the second year and 4kg in the third year (1kg plantain cost GH¢ 0.67). Plantain intercropped by cocoa farmers during the first three years of the establishment phase of their farm had an assumed yield of 1050kg/ha in the first year, 1225kg/ha in the second year and 700kg/ha in the third year. The production cycle for all shade levels was 30 years.

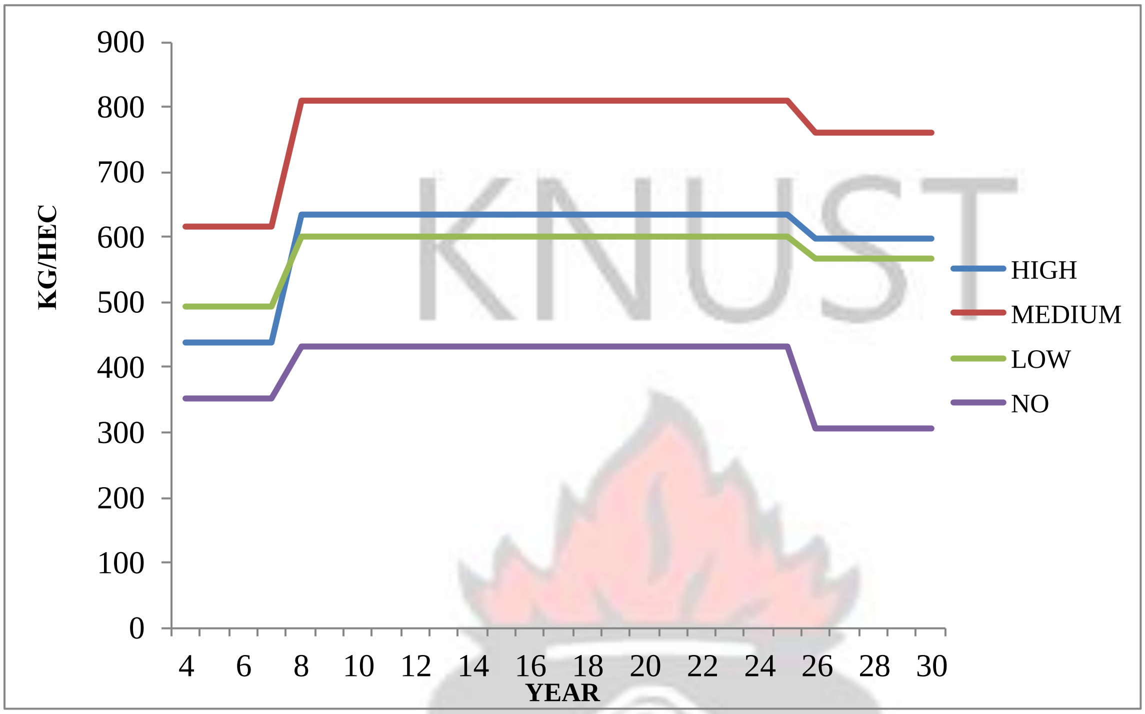



Fig.4.1 Output of cocoa for the various shade levels

Source: Field survey, 2014

For the output of cocoa, the high shade level of production yields 439.08 kg/ha from year 4-7, 633.47 kg/ha from year 8-25 and 599.14 kg/ha from the 26$^{th}$ to the 30$^{th}$ year. The medium shade level of production yields an output of 614.75 kg/ha from year 4-7, 809.55 kg/ha from year 8-25 and 761.14 kg/ha from the 25$^{th}$ to the 30$^{th}$ year. The output of cocoa for the low shade level of production was 493.33 kg/ha from year 4-7, 599.48 kg/ha from year 8-25 and 565.85kg/ha in the 25$^{th}$ to the 30$^{th}$ year. The no shade level of production yields an output of 351.25 kg/ha from year 4-7, 432.11 kg/ha from year 8-25 and 304.27 kg/ha in the 25$^{th}$ to the 30$^{th}$ year. Cocoa production under the various shade levels was low as compared to the world"s average of 1-1.5 tonnes per hectare. The low yields are attributed to poor management practices especially improper shade management which influences relative humidity and indirectly affect photosynthesis, diseases and pest infestation and weed control which can significantly reduce yield. The estimated cost of a 64 kg bag of the cocoa beans cost GH¢ 217 (GH¢ 3.4 per kg).

At the early stages of cocoa, there are high establishment costs which are then followed by annual benefits that are non-linear over the life of the trees. The cost for the various shade levels is represented by fig4.2. The cost for the first year consisted of both the investment cost and the operating cost. The cost for the rest of the years was operating and maintenance cost. The cost incurred under high shade level of production was higher in all years compared to the medium, low and no shade levels of production respectively. This was due to the frequency of use of labour for management practices resulting in a high cost of labour and the cost of inputs such as Insecticides, fungicides, mist blower (hiring), pruning of shade trees etc.

The benefit components included income from food crop (plantain) and timber. Perennial crops like cocoa generate a stream of costs and benefits over a given time period. From $4^{th}$-$7^{th}$ year, the revenue obtained from the medium shade level was highest followed by low, high and no shade level. From year 8-29, returns from medium was highest followed by high, low and no shade level. In the final year of the production cycle i.e. year 30, high shade had the highest revenue item, followed by medium, low and no shade levels of cocoa agroforestry production due to the sale of shade trees at an average stumpage fee of GH₵ 45/$m^3$ with an average size of 14$m^3$ giving a total stumpage price of GH₵ 630 as indicated in table 4.12. The stumpage price of the timber used in the calculations was based on the Forestry Commission of Ghana (2014) which is presented in appendix F. Although recent revisions to the Ghana Forestry Law accord property rights to those planting timber on their cocoa farm, the procedures for legally certifying that a timber tree was planted are not yet clear. Result of year 4-30 showed that plantations with shade trees have sustainable returns. This is consistent with the findings of Isaac *et. al* (2007). He reported that, trees in the cocoa growing systems contribute to sustaining production of cocoa.

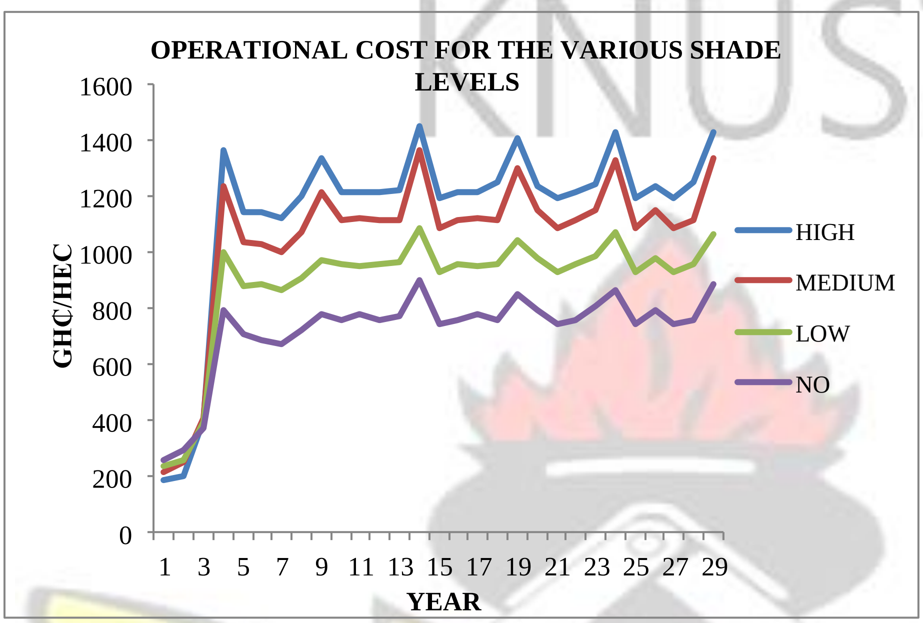



Fig 4.2 Operational cost for the various shade levels

Source: Field survey, 2014

Table 4.12 Monetary value of shade trees

| Tree species | Average size at 30 years ($m^3$) (a) | Stumpage price/$m^3$ (GH₵) (b) |
|---|---|---|
| *Khaya ivorensis* (African mahogany) | 12 $m^3$ | 67.58 |
| *Terminalia ivorensis* (Emire) | 12$m^3$ | 21.59 |
| *Terminalia superb* (Ofram) | 12m3 | 16.92 |
| *Milicia excelsa* (Odum) | 20m3 | 74.7 |

Source: FSD (2014)

### 4.3.2 Hectare Budget for the various shade levels

The hectare budgets for the various cocoa agroforestry shade levels have been provided for the early years of the plantation establishment and production cost (at the peak year i.e 8-25 years when the yield of cocoa is at its peak). The high shade had a per hectare establishment expenditure of GH¢ 692.50, a production expenditure of GH¢ 1443.00 and an expected income from cocoa of

GH¢ 2147.4633 per hectare. The medium shade level had an establishment and a production expenditure of GH¢ 747.50, and GH¢ 1361.00 respectively and an expected income from cocoa of GH¢ 2744.3745 per hectare. The low shade level had an establishment and a production expenditure of GH¢ 807.50 and GH¢ 1097.00 respectively with a per hectare expected income from cocoa of GH¢ 2032.2372. With no shade, the farmer spends GH¢ 935.00 per hectare on establishment and a production expenditure of GH¢ 920.00 and gets a return of GH¢ 1464.8529 from cocoa.

The expected revenue considered was mainly the output of cocoa and plantain in kilograms per hectare and the price per kilogram. The cost items included fixed and variable cost such as cost of cutlasses, insecticides, fungicides, mistblower, pneumatic sprayer, fertilizer etc. The units per hectare of the inputs, the life time of equipment, number of man-days and their unit value in Ghana cedis for cocoa agroforestry under each shade level are given for both establishment and operational activities. Hectare budgets of the various shade levels are presented in appendix A.

#### 4.3.3 Short Term Profitability Analysis

##### 4.3.3.1 Profitability of the Change from full sun cocoa plantation practice to the practice of the various cocoa agroforestry shade levels

The partial budgets are computed for the change from the full sun cocoa plantation practice to the various cocoa agroforestry shade levels. These were computed from the budget per hectare in appendix A.

A change from the full sun cocoa plantation practice to the high shade level had a change in net income of GH¢ 412.11 per hectare. With a change to the medium shade level, a change in net income of GH¢ 1026.02 per hectare was realized. A change to the low shade level had GH¢ 517.884 as a change in net-income.

The positive figures of the change in net income indicate that the change from the full sun cocoa plantation practice to cocoa agroforestry production at all shade levels is profitable in the short term given the current production and market conditions. On the basis of the change in net income, farmers would practice the various cocoa agroforestry levels because it increases their net income.

### 4.3.4 Long term viability analysis

#### 4.3.4.1 Financial Viability of the Various Shade Levels of Cocoa Agroforestry Production

In the evaluation of the private profitability of cocoa agroforestry under the various shade levels, the budget used assumes that only wage labour is employed for the production in all operations, therefore all family labourers are treated as hired labourers. The cost elements included variable and fixed costs. Various items considered are affixed to this document under the appendices. .

The cost-benefit analysis per hectare of high shade cocoa agroforestry at 30% discount rate for a 30-years production cycle indicated a negative NPV of -245.60 per hectare and an FRR of 26.67%. An NPV of -245.60 implies that the difference between the present worth of benefit and the present worth of cost was -245.60 at a discount rate of 30%. The negative net present value indicates that, the high shade cocoa agroforestry level is not able to recover its costs neither is it able to pay the farmer for his investment. The IRR was 26.67% which is less than the opportunity cost of capital of 30%. The FRR of 26.67% means that at a discount rate of 26.67% the project just break even. This means that the high shade cocoa agroforestry level will earn back all the capital and operating cost expended on it and pays us 26.67% for the use of our money. It is therefore better to put your money in the bank at the prevailing interest rate than to invest in the high shade level and earn 26.67%. We fail to accept the high shade level cocoa agroforestry production. The decision rule with the IRR (FRR) is to accept projects with IRRs equal to or higher than the opportunity cost of capital. This implies that high shade level of cocoa agroforestry production is not viable since it could not pay for the factors of production and hence make a profit. Farmers with this shade level may not have the required capital to purchase the necessary inputs needed for efficient production and to pay for the services of labourers.

The cost-benefit analysis estimated for 1 hectare medium shade cocoa agroforestry for a thirtyyear period at 30% discount rate indicated that the NPV for medium shade level of cocoa agroforestry production was positive and estimated to be 719.58. An NPV of 719.58 implies that the difference between the present worth of benefit and the present worth of cost was 719.58 at a discount rate of 30% while the IRR was 37.77% which is more than the opportunity cost of capital. The FRR of 37.77% means that at a discount rate of 37.77% the project just break even. This means that the medium shade cocoa agroforestry level will earn back all the capital and operating cost expended on it and pays us 37.77% for the use of our money. This result indicates that medium shade level of cocoa agroforestry production was more viable. Ruf and Zadi (1998) reported in their study that incorporating desirable and fast growing trees, firmly in the cocoa growing system contribute to the rehabilitation of cocoa farms in the corridor of cocoa growing areas and the consequence of this is a well-developed sustainable Farming system, which may prolong and increase farm yields. It could be seen that the maintenance cost per hectare of the medium shade level were higher compared to the low and no shade level of production but these costs were recovered by the higher gross income since they could pay for the factors of production and generate profit.

The results of the Low shade level showed that the calculated NPV was positive with a value of 135.91 per hectare. This figure was higher than the calculated NPV for no and high shade levels of cocoa agroforestry production and lower than that of the medium shade level. The FRR for low shade level was 31.64% which was also higher than 26.67% and 23.39% of the high and no shade levels respectively. The study revealed that low shade level was more viable than the high and then the no shade levels. Although these results indicated viability of the low shade level of cocoa agroforestry production in absolute terms, it is quite evident that it is the less viable relative to medium shade level of cocoa agroforestry production.

The cost-benefit analysis for cocoa per hectare at 30% discount rate for full sun plantation for a thirty-year period indicated a negative NPV of -509.54 per hectare and an FRR of 23.39% which was less than the opportunity cost of capital of 30%. The decision rule with NPV is to accept projects with positive NPVs and that of IRR (FRR) is to accept projects with IRRs equal to or higher than the opportunity cost of capital. This clearly showed that, the full sun plantation was not viable since it could not pay for the factors of production and make profit. These figures were lower than the calculated NPV and FRR for high shade level of cocoa agroforestry production. The study revealed that the full sun plantation was less viable in terms of both NPV and FRR than the high shade level of cocoa agroforestry production although this result indicated nonviability. Farmers under this level would be operating at stage one of the production process.

Rahman et al. (2007) documented that, plantations with shade gives better NPV"s than full sun plantations and it is more profitable as well as less risky.

#### 4.3.4.2 Economic Viability of the Various Shade Levels of Cocoa Agroforestry Production

The costs and benefits for the various shade levels of cocoa agroforestry production from the society"s point of view.. This was attained by valuing inputs and outputs at their opportunity cost.

The cost-benefit analysis estimated for 1 hectare high shade cocoa agroforestry for a thirty-year period at 18% discount rate indicated a positive NPV of 8140.44 per hectare and ERR of 64.19%, which was greater than the opportunity cost of capital. These results showed that the high shade level of cocoa agroforestry production was viable since they could pay for the factors of production and make profit. High shade level of production was more viable compared to the full sun plantation (no shade level of cocoa agroforestry production). Although the results indicated viability of the high shade level of production in absolute terms from the public perspective, it was quite evident that is less viable relative to the medium and the low shade levels.

The cost-benefit analysis per hectare of medium shade cocoa agroforestry at 18% discount rate for a 30-years production cycle had a positive and estimated to be 10883.14. An NPV of 10883.14

implies that the difference between the present worth of benefit and the present worth of cost is 10883.14 at a discount rate of 18% while the ERR was 73.29% which is greater than the opportunity cost of capital. The ERR of 73.29% indicates that at a discount rate of 73.29% the project just break even. This means that the medium shade level of cocoa agroforestry will earn back all the capital and operating cost expended on it and pays us 73.29% for the use of our money. This shows that medium shade level of cocoa agroforestry production was more viable.

Ruf and Zadi (1998) reported in their study that incorporating desirable and fast growing trees, firmly in the cocoa growing system contribute to the rehabilitation of cocoa farms in the corridor of cocoa growing areas and the consequence of this is a well-developed sustainable Farming system, which may prolong and increase farm yields. The maintenance cost per hectare were higher compared to the low shade level of production but these costs were recovered by the higher gross income since they could pay for the factors of production and generate profit. Societies operating under medium shade level would be operating at the stage two of the production process.

The results of the cost-benefit analysis estimated for low shade level at 18% discount rate for 30 years production cycle indicated a positive NPV with a value of 7981.69 per hectare. This figure was higher than the calculated NPV for high and then no shade levels and lower than that of the medium shade level. The ERR for low shade level was 66.47% which was also higher than 64.19% and 56.51% of the high and no shade levels respectively. From the study low shade level of production was more viable as compared to high and no shade level. Although these results indicated viability of the low shade level, it is less viable relative to medium shade level.

A positive NPV of 5138.08 was obtained for full sun plantation with an ERR of 56.51% at 18% discount rate for a 30-year production cycle. The no shade level was viable but relatively less viable compared to the medium, low and then high shade as can be seen in appendix E4. Rahman et al. (2007) documented that, plantations with shade gives better NPV‟s than full sun plantations and it is more profitable as well as less risky.

### 4.3.5 Comparing Economic and Financial Viabilities of the Various Shade Levels

At all shade levels of cocoa agroforestry production, the projects were more attractive to the society than the individual or private investor, if only the internal rate of return and the net present value are used as decision criteria as shown in table 4.13. This is because at current agricultural lending rate, farmers buy most of their inputs at the open market and thus do not enjoy any form of subsidy. The investment costs to the farmer are too high and the producer price is not high enough to increase returns from the exercise. Also given the same level of technology a project will be more socially viable compared to its financial viability this is because where there is unemployment and social pressure for higher wages, the market price of labour is generally higher than its scarcity value (Gittinger, 1982). A study revealed by Ruf and Zadi (1998) also showed that cocoa production is a profitable business irrespective of the management system.

For financial analysis, the order of viability ranges from medium, low, high and then no shade level of cocoa agroforestry production. Also for economic analysis the order ranges from medium, low, high and then no shade level of cocoa agroforestry production. The high shade level was not viable under private perspective but less viable compared to medium and low under the society‟s point of view. This was due to the frequency of use of labour and inputs for management practices in the high shade level of cocoa agroforestry resulting in a high cost of labour and the cost of inputs such as Insecticides, fungicides, mist blower (hiring), pruning and thinning of shade trees etc. This labour cost was very high for the private investor but lower for the public. The no shade level was relatively low compared to all the other shade levels from both the private and society point of view due to non-sustainability of yield over the plantations life cycle. A study by Obiri *et al.* (2007) compares hybrid, shaded hybrid and traditional cocoa and found that, from an economic perspective, cocoa production will remain, in general, profitable, even in case of a 20% reduction in cocoa price or yield. This is also in line with what Current *et. al*. (1995) revealed that many agroforestry practices are profitable under a broad range of conditions than monoculture plantations and are therefore likely to be widely applicable.

**Table 4.13 The NPV's and the IRR's for the Various Shade Levels**

| | High | Medium | Low | No |
|---|---|---|---|---|
| | Financial Analysis | | | |
| Financial Rate of Return (FRR) | 26.67% | 37.77% | 31.64% | 23.39% |
| NPV at 30% | -245.60 | 719.58 | 135.91 | -509.54 |
| | Economic Analysis | | | |
| Economic Rate of Return (ERR) | 64.19% | 73.29% | 66.47% | 56.51% |
| NPV at 18% | 8140.44 | 10883.14 | 7981.69 | 5138.08 |

Data analysis, 2014

### 4.3.6 Constraints to Cocoa Agroforestry Production

Cocoa agroforestry is likely to encounter a lot of problems. Notable ones in the study area included; Lack of adequate knowledge on the benefits derived from the inclusion of shade trees in cocoa plantations, Lack of knowledge of which species to plant and how to plant them, Lack of knowledge on logging regulations/ procedures, Lack of seedlings, Inadequate compensation for destroyed crops, Seasonal occurrence of plant pest, Tree tenure, Lack of credit facilities and Farm size among others as indicated in table 4.14.

It was noticed that, 54.4% of the respondents considered lack adequate knowledge on the benefits derived from the inclusion of shade trees in cocoa plantations as a threat to the adoption of cocoa agroforestry production. Rice and Greenberg, (2000), stated that, the knowledge of the benefits of agroforestry will motivate farmers to leave trees in their plantations. Such benefits includes that agroforestry reduces light intensity, temperature and air movement, leaf litter from shade trees provides mulch and a supply of organic matter for the soil and influences relative humidity which indirectly affects photosynthesis, yield and pest and disease management.

58.5% of the farmers in the study area said that lacked adequate knowledge of which species to plant and how to plant them is constrain to cocoa agroforestry production. That is, the shade trees that have desirable qualities such as; minimal competition with crops for nutrients, water and light, ease of establishment and rapid production of leaves, provision of humid microclimate, does not favour alternative host for pest and crop diseases, provision of alternative tree products and additional income, no or minimal leave and branch shedding, high litter production and a strong rooting system to prevent wind throw. Amanor (1996), documented that the main reasons why farmers do not plant trees (outside ownership issues and lack of land) include; lack of a tree planting culture and knowledge of which species to plant and how to plant them and also lack of seeds. This will motivate and direct farmers to leave or plant such trees.

61.5% of the respondents indicated lacked adequate knowledge on logging regulations, and procedures on rights to compensation caused by tree felling as a threat to cocoa agroforestry production. Timber contractors and chainsaw operators exploit the farmers to their disadvantage. As a result, a lot of timber species on farms are felled, without the consent of the farmers. Most farmers are therefore not motivated to either leave such trees or plants them on their farms. Richards and Asare (2000) stated in their study that inadequate education on regulations and procedures to logging and compensation rights have resulted in the exploitation of farmers by operators.

About 45.9% of the farmers indicated that lack of seedlings serves as a constraint to the adoption of cocoa agroforestry in the study area. Readily available planting materials can induce farmers to plant trees.  Farmers are not interested in planting trees on their farms because they do not have access to the seedlings. The Forestry Services Division (FSD), which initially provided free seedlings for planting by farmers, has however stopped. Lack of a tree planting culture and knowledge of which species to plant and how to plant them and also lack of seeds are the main reasons why farmers do not plant trees outside ownership issues and lack of land, as stated by Amanor (1996).

74.4% respondents in the study area considered inadequate compensation for cocoa trees destruction caused during harvesting of timber species by contractors as a limiting factor to the adoption of cocoa agroforestry. Due to this, some farmers are therefore willing to use or sell some of their shade trees themselves to avoid future destruction of their cocoa trees during felling by other chainsaw operators and timber contractors who do that without their consent. Richards and Asare (2000) stated in their study that inadequate compensation is one of the limiting factors to cocoa agroforestry adoption and this situation has resulted in many farmers destroying valuable timber trees to avoid the risk of uncompensated damage.

The seasonal occurrence of plant pest and disease in the study area is a threat to cocoa agroforestry as indicated by 35.6% of the farmers. Some of the shade trees are alternative host to pest of the cocoa trees. Richards and Asare (2000) revealed in their study that, some of the shade trees can build up capsids, which feed on cocoa shoots and cause defoliation and mealy bugs which can carry swollen shoot diseases; viral die-back problem. This result in extra input cost such as the purchase of insecticides and fungicides and also consequently reduces crop yield.

Thus, some respondents were not motivated to plant shade trees.

24.4% of the farmers said that unawareness of ownership right concerning the growing of trees on farms (tree tenure) results in the unwillingness of farmers to plant trees. Farmers do not see the need for leaving trees on their farms whilst they do not own them but the government does and even compensation for damaged crops during felling is not satisfactory. Fortman (1985) stated that agroforestry depends on people‟s right to plant and use trees and these rights in turn depend on the prevailing system of land and tree tenure. This therefore calls for education on tree tenureship in the communities.

Unavailability of credit facilities for the expansion of farms sizes and the purchase of tree seedlings and other farm inputs was also considered as a constrain to cocoa agroforestry production as indicated by 32.6% farmers in the study area. Credit availability is an important factor which can influence adoption of a technology. This is because it reduces the liquidity constraints so the farmer can purchase the inputs required, Owusu (1993).

45.6% of the farmers also considered farm sizes as a limiting factor to the adoption of cocoa agroforestry. Some of the farmers complained that their area is too small for a diversified agroforestry system endeavor and also shade trees would result in shading of their crops and in result lower yields. Due to this some farmers who have these shade trees were willing to eliminate some of these trees and some of the respondents were not willing to fully and consciously adopt this system. This is in line with the finding of Polinar (2007) as he reported that, respondents had expressed sentiments that shortage of land or smaller farm size is the primary reason for not planting sufficient number of tree stems.

Table 4.14 Constraints to Cocoa Agroforestry Production

| Constraints | Frequency of farmers | Percentage (%) |
|---|---|---|
| Lack of adequate knowledge on the benefits derived from the inclusion of shade trees in cocoa plantations | 147 | 54.4 |
| Lack of knowledge of which species to plant and how to plant them | 158 | 58.5 |
| Lack of knowledge on logging regulations/ procedures | 166 | 61.5 |
| Lack of seedlings | 124 | 45.9 |
| Inadequate compensation for destroyed crops | 201 | 74.4 |
| Seasonal occurrence of plant pest | 96 | 35.6 |
| Tree tenure | 66 | 24.4 |
| Lack of credit facilities | 88 | 32.6 |
| Farm size | 123 | 45.6 |

Source: Field survey, 2014

# CHAPTER FIVE

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Summary of Findings

1. The study revealed that, a change from the practice of full sun cocoa plantation to cocoa agroforestry at all shade levels is profitable in the short term given the current production and market conditions. The medium shade level was most profitable, followed by the low and then the high shade levels.

2. The results clearly demonstrated that in the long term financial analysis the medium shade level can generate internal returns of 37.77%, compared to the low (31.64%), high (26.67%) and no (23.39%) shade levels. With reference to the market rate at 30% we accept the project at the medium and low shade levels and reject the project at high and no shade levels. This implies that the medium and low shade levels are viable compared to the high and no shade levels.

3. The economic analysis results showed that cocoa production is a profitable business irrespective of the shade level, since all of them had positive NPV at 18% discount rate. The medium shade level generated the highest internal returns followed by low, high and the No shade levels. Thus under price projections cocoa agroforestry is more socially attractive than being financially attractive at all shade levels.

In view of the hypothesis that, as shade level for cocoa agroforestry increases, the financial and economic viability of cocoa agroforestry decreases, it can be said that the hypothesis does not hold from both the investors and society‟s point of view.

4. The study conducted also revealed that there is a high opportunity for the conscious introduction and motivation of existing cocoa agroforestry in the study area. However, the inadequate education on; the benefits derived from the inclusion of shade trees in cocoa plantations, which species to plant and how to plant them, tenure ship and logging as well as inadequate compensation for destroyed crops are possible threats to the realization of the full benefit of the cocoa agroforestry system.

5. The study showed that, sustainable yield, soil fertility improvement, erosion control, multiple revenue, weed control, biodiversity enrichment, moisture improvement, microclimate creation, mistletoe control and wind breaks are the intangible social and environmental benefits of cocoa agroforestry in the study area.

### 5.2 Policy Recommendations

Policy recommendations are crucial to bring major changes in cocoa agroforestry practice in Ghana. Even though there is an agroforestry policy in Ghana, research strategies and priorities, extension strategies and packages, socio-economic factors, agroforestry education and training, and institutional issues are all important to be addressed or reviewed. Based on the main findings from the study, the following recommendations are outlined for policy:

1. An education programme should be designed and carried out with the purpose to promote the practice of cocoa agroforestry and improve the system where it already exists. From data collected, it was observed that farmers in the study area needed education on several aspects of agroforestry and essential legislation and procedures that can be beneficial when adopting or improving the system. The Forestry Services Division in collaboration with the Community Forestry Committees (CFCs) and other relevant stakeholders will have to prepare an awareness programme with specific attention given to the benefits of the inclusion of shade trees in cocoa cultivation, tree tenureship and the rights of farmers and communities with regards to tree logging and compensation for destroyed crops. This education programme must be an integral part of the government‟s forest policy. After having educated the farmers on the benefits, the regulations and the compensations for crops damaged, there might be an increasing interest in practicing agroforestry.

2. Policies aiming at promoting tree ownership rights among cocoa farmers should be formulated and enforced.

3. Cocoa agroforestry is more attractive to the government than to the farmers at all shade levels but cocoa is cultivated by private individuals and is a major source of government revenue for the provision of socio-economic infrastructure. Incentives such as the provision of desirable fast growing shade tree seedlings to farmers and premium prices for quality cocoa grown under shade should therefore be provided by the government to encourage private people into cocoa agroforestry production especially the medium and low shade levels which are viable to the farmers.

## 5.3 Limitations of the Study and Suggestions for Future Research

1. Data from Ashanti region of Ghana was only used for the analysis.

   Since data from only one region was used for this analysis, further research should consider data from other cocoa growing regions to check whether the results are similar.

2. The economic characteristics described in the preceding paragraphs are restricted to direct use values.

   Further research should include indirect use values and non-use values in the analysis. This would be likely to enhance the worth of the shade levels adopted for agroforestry, particularly the medium and low shade levels with higher returns.

   The total economic value of natural resources includes both use and non-use values. Use values can be direct or indirect. Non-use values are public goods and commonly reflect values perceived by society for the existence of resources or the option to use them later.

## REFERENCES


ADB (2002), Asian Development Bank‟s Guidelines for the Economic Analysis of project Analysis; Retrieved 30 April 2010, from http://www.proventionconsortium.org/?pageid=26.

ADB (2004). Asian Development Bank‟s Guidelines for the Economic Analysis of project Analysis. Retrieved 30 April 2010, from http://www.compliance.adb.org/dir0035p.nsf/.../CRP_AnnualRpt2004-full.pdf.

ADB (2005), Asian Development Bank‟s Guidelines for the Economic Analysis of Project Analysis (Reviewed by Anand P. B, 30 November, 2004 Review No 27); Retrieved 30 April 2010, from http://www.dfid.gov.uk/Documents/publications/mdes/AsDB.pdf

Adesina, A.A., Mbila C., Nkamleu, G.B., and Endamana, D. (2000). "Analysis of the Determinants of Adoption of Alley Farming by Farmers in the Forest Zone of Southwest. Cameroon". *Agriculture, Ecosystems & Environment*, 80, 255-265.

Adetunji M.O., O.A Olaniyi and M.O Raufu. (2007). Assessment of Benefits Derived by Cocoa Farmers from Cocoa Development Unit Activities of Oyo State. *Journal of Human Ecology. 22(3): 211-214.*

Aidoo, R. (2009). Economic Analysis of the Modified Taungya System (MTS) in the Transitional Zone of Ashanti Region, Ghana. KNUST, Kumasi, Ghana.

Albrecht, A. & Kandji, S. T. (2003), „Carbon sequestration in tropical agroforestry systems‟, Agriculture, Ecosystems & Environment 99(1-3), 15–27.

Almeida, A. F. D. & Valle, R. R. (2008), „Ecophysiology of the cacao tree‟, 19(i), 425–448.

Amanor, K.S. (1996). Managing trees in the farming system: The perspective of farmers. Forest Farming Series No. 1, Forest Department, Ghana, Pp. 198

Anim-Kwapong, J. and Frimpong, E. B. (2005). Vulnerability of agriculture to climate change-impact of climate change on cocoa production. Cocoa Research Institute of Ghana. New Tafo Akim

Asare, Richard (2005). ―Cocoa agroforests in West Africa: a look at activities on preferred trees in the farming systems‖. Forest & Landscape Working Papers no. 6.

Asare, R. (2006). A review on cocoa agroforestry as a means for biodiversity conservation. World Cocoa Foundation Partnership Conference, Brussels. 16 pp.

Asare, R. (2005). Cocoa Agroforests in West Africa. A Look at Activities on Preferred Trees in the Farming Systems. Forest and Landscape Working Papers no. 6-2005 Denmark. Asare, R., David, S. and Sonwa, D. (eds.) (2009). Conservation and biodiversity in and around cocoa farms. Learning about Sustainable Cocoa Production: A Guide for Participatory Farmer Training. Development and Environment Series 12-2009. Forest & Landscape Denmark.

Asare, R. and David, S. (2010). Planting, replanting and tree diversification in cocoa systems. Learning about sustainable cocoa production: a guide for participatory farmer training. Manual No. 2. Development and Environment Series 13-2010. Forest & Landscape Denmark.

Balogun O. L. (2011). Determinants of managerial abilities of small scale cocoa farmers: Akinyele Lga of Oyo State of Nigeria. *ARPN Journal of Agricultural and Biological Science, Department of Agricultural Economics*, University of Ibadan, Nigeria

Bisseleua, D., Missoup, A. & Vidal, S. (2009), „Biodiversity conservation, ecosystem functioning,and economic incentives under cocoa agroforestry intensification‟, Conservation biology **23**(5), 1176–1184.

Boni, S., Nuhu, R. I., Reuter, F. and Da Re, G. (2004). Anthropological, Environmental and Soils Assessment of the Sefwi Wiawso District, Ghana. Ricerca e Cooperazione, European Commission, Italy. 202pp.

Codjoe F. (2013). Analysis of Cocoa-Based Agricultural Knowledge and Information Systems in the Eastern Region of Ghana. *Russian Journal of Agricultural and Socio Economic Sciences, 2(14).* Department Of Agricultural Economics And Agribusiness, University Of Ghana, Ghana

Current D., Lutz E., and Scherr S. J (1995). The Costs And Benefits Of Agroforestry To Farmers. The World Bank Research Observer, vol. 10, no. 2 (August, 1995).

Danso-Abbeam, G. (2012). Empirical analysis of productivity and resource-use-efficiency in Ghana‟s cocoa industry: evidence from Bibiani-Anhiawso-Bekwai District. Published Mphil thesis. Department of Agricultural Economics, Agribusiness and Extension, KNUST, Ghana.

Duguma, B., Gockowski, J. & Bakala, J. (1998). Smallholder cocoa (*Theobroma cacao*) cultivation in agroforestry systems of west and central Africa: challenges and opportunities. Paper from workshop held in Panama, 3/30-4/2, 1998. Smithsonian institution. Washington, D.C

Ellis, F. (1992). Agricultural policies in Developing Countries. Cambridge University Press. Great Britain.

FAO (2002). ―Etude de cas d„aménagement forestier exemplaire en Afrique centrale: les systèmes agroforestiers cacaoyers, Cameroun‖. Par Denis J. Sonwa, octobre 2002. Document de travail FM/12F. Service de la mise en valeur des ressources forestières, Division des ressources forestières. FAO, Rome (non publié). 17

FiBL, IFOAM & Sippo (2002), „Organic Coffe, Cocoa and Tea: Market, certification and production information for producers and international trading companies‟. Garrison R. H (1999). Accounting for management. Retrieved 3rd May, 2010 from http://www.accountingformanagement.com/ray_h_garrison.htm

Gittinger J. P (1984). Economic analysis of Agricultural projects. 2nd Edition, Completely Revised and Expanded. SDI Series in Economic Development. The John Hopkins University Press. London.

Gittinger, J.P. (1982). Economic analysis of agricultural projects (2nd edition). John Hopkins University Press,Baltimore, Maryland, USA. 505pp.

Gockowski, J. & Sonwa, D. (2011), „Cocoa intensification scenarios and their predicted impact on CO emissions, biodiversity conservation, and rural livelihoods in the Guinea rain forest of West Africa.‟, Environmental management (2), 307–21.

Gockowski, J., Afari-Sefa, V., Sarpong, D. B., Osei-Asare, Y. B. & Agyeman, N. F. (2013), „Improving the productivity and income of ghanaian cocoa farmers while maintaining environmental services: what role for certification?‟, International Journal of Agricultural Sustainability **11**(4), 331–346.

Gray A. (2001). The World Cocoa Market Outlook, Ghana Conference paper, May 2000, LMC International Ltd, Ghana.

Gyau, A., Smoot, K., Kouame, C., Diby, L., Kahia, J. & Ofori, D. (2014), „Farmer attitudes and intentions towards trees in cocoa (theobroma cacao l.) farms in cˆote divoire‟, Agroforestry Systems **88**(6), 1035–1045.

Horton D. (1982). Partial Budget Analysis for On-Farm Potato Research. *Technical Information Bulletin 16, International Potato Center (CIP), Lima - Peru* pg 5

ICCO (2014), „Cocoa Market Review‟, (August), 2013–2014.

Isaac, M.E., Timmer, V.R. and Quashie-Sam, J. (2007). Shade tree effects in an 8-year-old cocoa agroforestry system: Biomass and nutrient diagnosis of *Theobroma cacao* by vector analysis. *Nutrient Cycling in Agroecosystems* 78: 155-165.

Lehmann J. & Joseph J. (2009). *Biochar for Environmental Management Science and Technology*. Earthscan, Dunstan House- London. ISBN: 978-1-84407-658-1.

Losch, B. (2002) "Global Restructuring and Liberalization: Côte d 'Ivoire and the End of the International Cocoa Market?" April 2002. *Journal of Agrarian Change*. 2:2, 206–227.

Blackwell Synergy. Retrieved on 3 March 2007.

Manivong, V. & Cramb, R. A. (2008), „Economics of smallholder rubber expansion in northern laos‟, Agroforestry Systems 74(2), 113–125.

Ministry of Finance, (1999). Feasibility study on replanting of cocoa in denuded cocoa areas in Ghana. Ministry of Finance, Accra-Ghana. September 1999.

Ministry of Finance and Development Planning. (1986). Planning officer's manual. Government Printer, Gaborone, Botswana. 128pp.

Nkang, N. (2009). Investment In Cocoa Production In Nigeria: A Cost And Return Analysis Of Three Cocoa Production Management Systems In The Cross River State Cocoa Belt. Published by Rural Outreach Program. Nigeria. P 719-720.

Obiri, B. D., G. A. Bright, M. A. McDonald, L. C. N. Anglaaere and J. Cobbina (2007). Agroforest Syst 71: 139–149.

Ofori F., Stennett H.R. and Dampson J.A. (1990). Agroforestry. An option for Revising Environmental Degradation and Improving Agricultural Productivity, Proceedings of the National Workshop on Agroforestry, Unit, Crop Services Department, Ministry of Food and Agriculture (MOFA), Accra, Ghana.

Owusu, Y. (1993), Farm-based Agroforestry: four years of experience in Ghana (*Agroforestry Today*) Vol. 5. No. 1. Pp 8 and 9.

Padi, B. and Owusu, G. K. (1998). Towards an Integrated Pest Management for Sustainable Cocoa Production in Ghana. Paper from workshop held in Panama, 3/30-4/2, 1998. Smithsonian Institution, Washington, D.C.

Polinar A. N. (2007). Economic Prospects Of Small-Scale Tree Farms In Bontoc, Southern Leyte.

Rahman, S.A, Farhana, K.M, Rahman, A.H.M.M, and Imtiaj, A. (2007). An Economic Evaluation of the Multistrata Agroforestry System in Northern Bangladesh. IDOSI Publications, 2007, Bangladesh.

Rice, R.A. and Greenberg, R., (2000). Cacao cultivation and the conservation of biological diversity; Ambio 29: 81-87

Richards M. and Asare A. (2000). Economic incentives for cocoa farmers to tend timber trees in southern Ghana. Ghana

Ruf, F. and Zadi, H. (1998). Cocoa: from deforestation to reforestation. Paper from workshop on Shade Grown Cocoa held in Panama, 3/30-4/2, 1998. Smithsonian institution, Washington, D.C.

Ruf, F. O. (2011). The myth of complex cocoa agroforests: the case of Ghana. Hum Ecol 39, 3: 373–388.

Sakanashi, K. (2010), „Cocoa-based Agroforestry in Southern Cameroon: Is it Real or Ideal? History of Agroforestry", pp. 252–262.

Schroth, G., Krauss, U., Gasparotto, L. & Duarte, J. A. (2000), „Pests and diseases in agroforestrysystems of the humid tropics", pp. 199–241.

Sonwa, Denis Jean (2004). Biomass management and diversification within cocoa agroforests in the humid forest zone of Southern Cameroon. PhD thesis. Faculty of Agriculture. University of Bonn. Germany. Cuvillier Verlag, Goettingen. 112 pp.

Sonwa, D. J., and S. F. Weise (2008). Diversifying and Intensifying the Cocoa Agroforest Landscape: Review and strategic approaches for managing the shade matrix in West and Central Africa. STCP Working Paper Series, Issue 4 (version January 2008). International Institute of Tropical Agriculture, Accra, Ghana.

Sonwa, D. J., A. B. Nkongmeneck, S. F., Weise, M. Tchatat and J. J. Janssens (2008). Chocolate Forest and the Peri-Urban Landscape: Tree diversity of the cocoa agroforests around Yaoundé (Southern Cameroon).Tropical Agriculture, STCPWorking Paper Series Issue 5 Sonwa, D. J., A. B. Nkongmeneck, S. F. Weise, M. Tchatat and M. J. J. Janssens (2009). Tree diversity of the cocoa agroforest around Yaoundé (Southern Cameroon). In: X. van der Verchot, L. V., Van Noordwijk, M., Kandji, S., Tomich, T., Ong, C., Albrecht, A., Mackensen,

J., Bantilan, C., Anupama, K. & Palm, C. (2007), „Climate change: linking adaptation and mitigation through agroforestry", Mitigation and adaptation strategies for global change 12 (5), 901–918.

Waldron, A.; R. Justicia, L. Smith, Sanchez M. and Wiley-Blackwell (2012). Conservation through Chocolate: a win-win for biodiversity and farmers in Ecuador's lowland tropics. Boston, USA, Conservation Letters, 5, 3: 213-221.

Wharton, A. L. (1962). „Black pod and Minor Diseases" in Agriculture and Land use in Ghana (Wills J.B. ed) Oxf. Univ. Press, London.

Wagonhurst C. (2005). Budget Preparation. Retrieved 30th April 2010 from http://www.virginia.edu/polproc/pol/viiia8.html www.ghanadistricts.com – Website created by the Ministry of Local Government and Rural

Development in Accra, Ghana (2014).

APPENDICES

A. Private Hectare Budget for cocoa agroforestry High shade level

| COST | Units Per Hectare (E.G. No. Of Man-Days) | Unit Value (Ghana Cedis) | Life Time Of Equipment: Number Of Years | Cost Per Hectare Ghana (Cedis) |
|---|---|---|---|---|
| A. Cost of Establishment | | | | |

| Planting on secondary forest | | i). Land preparation | |
|---|---|---|---|
| Labour costs | | | |
| Land clearing | 12 | 10 | 120.00 |
| Felling and chopping big trees | 1 | 15 | 15.00 |
| Controlled burning | 2 | 10 | 20.00 |
| Clearing stumps | 1 | 10 | 10.00 |
| Preparation of pegs | 2 | 10 | 20.00 |
| Lining and pegging | 4 | 15.5 | 62.00 |
| Other labour costs | | | |
| Inputs and equipment (if purchased by the farmer) | | | |
| Machetes | 1 | 8 | 8.00 |
| Other equipment (specify) | | | |

| ii) Preparation and planting of seedlings | | | |
|---|---|---|---|
| Labour costs | | | |
| Setting up nursery | 4 | 10 | 40.00 |
| Care of cocoa seedlings (up to 6 months) | 10 | 8.5 | 85.00 |
| Holing/planting of plantain suckers | 5 | 10 | 50.00 |
| Holing for planting cocoa seedlings | 5 | 8.5 | 42.50 |
| Carting of cocoa seedlings (average distance of 2 km) | 8 | 5 | 40.00 |
| Planting of cocoa seedlings | 5 | 6 | 30.00 |
| Other labour costs: fertilizer application | | | |
| Inputs and equipment | | | |
| Top soil | 1 | 40 | 40.00 |
| Bamboos and palm fronds | | | |
| Polyethylene bags for nursery | 1500 | 0.02 | 30.00 |
| Planting material: hybrid pods | 50 | 0.4 | 20.00 |
| Planting material: plantain suckers | 500 | 0.1 | 50.00 |
| Fertilizer | | | |
| Type a: sulphate of ammonia | | | |
| Type b: | | | |
| Type c: | | | |
| Other equipment: Earth chisel | 1 | 10 | 10.00 |

| | | | | |
|---|---|---|---|---|
| Total costs per hectare (a) | | | | 692.50 |
| NB. Cost of one hectare of land = 1100 Ghana cedis | | | | |
| PRODUCTION COST | | | | |
| i). Maintenance | | | | |
| Labour costs | | | | |
| Weeding | 12 | 10 | | 120.00 |
| Spraying :Pest control | 3 | 20 | | 60.00 |
| Spraying : Disease control | 4 | 15 | | 60.00 |
| Pruning :shade trees (Sanitation, chupon, canopy) | 8 | 10 | | 80.00 |
| Thinning :shade trees | 6 | 10 | | 60.00 |
| Pruning :cocoa trees | 6 | 10 | | 60.00 |
| Thinning :cocoa trees | 4 | 10 | | 40.00 |
| Fertilizer application | 1 | 12 | | 12.00 |
| Mistletoe control | 8 | 15 | | 120.00 |
| Other labour costs | | | | |
| Inputs and equipment | | | | |
| Cutlass | 2 pieces | 12 | | 24.00 |
| Weedicides | | | | |
| Insecticides | 3 litres | 10 | | 30.00 |
| Fungicides | 6 sachets | 5 | | 30.00 |
| Fertilizer | 1x50Kg | 55 | | 55.00 |
| Mistblower (hiring) | 2x3 | 10 | | 60.00 |
| Pneumatic Sprayer (hiring) | 2x6 | 4 | | 48.00 |
| Axe | | | | |
| Other equipment | | | | |
| Knapsack | 1 | 30 | 5 years | 30.00 |
| Wellingtonboots | 1 | 20 | 3 years | 20.00 |
| Protective Clothes | | | 3 years | |
| ii). Harvesting | | | | |
| Labour | | | | |
| Plucking of Pods | 4 | 6 | | 24.00 |
| Gathering and Heaping | 5 | 4 | | 20.00 |
| Pod-breaking and Fermenting | 9 | 7 | | 63.00 |
| Other Labour costs | | | | |
| Harvesting and carting plantain bunches | 6 | 5 | | 30.00 |
| Inputs and Equipment | | | | |
| Baskets | 5 | 5 | 2 years | 25.00 |
| Harvesting Hooks | 1 | 5 | 5 years | 5.00 |
| Machetes | 2 | 4 | 1 year | 8.00 |

| | | | | |
|---|---|---|---|---|
| Other equipment: sharpening stones | 1 | 5 | 1 year | 5.00 |
| iii). Post Harvest | | | | |
| Labour | | | | |
| Carting of fermented beans 9 5 45.00 | Drying 2 x 14 days 3 84.00 | | | |
| Erecting platform | 2 | 5 | | 10.00 |
| Bagging and carting | 3 | 5 | | 15.00 |
| Inputs and equipment Drying mat | 2 | 100 | 5 years | 200.00 |
| Total current costs (b) | | | | 1443.00 |
| EXPECTED COCOA YIELD (kg/ha) | 633.47 | 3.39 | | 2147.4633 |
| PLANTAIN YIELD (kg/ha) | 1225 | 0.67 | | 820.75 |

Source: Field Data, 2014

B. Economic Hectare Budget for cocoa agroforestry High shade level

| COST | Units Per Hectare (E.G. No. Of Man-Days) | Unit Value (Ghana Cedis) | Life Time Of Equipment: Number Of Years | Cost Per Hectare Ghana (Cedis) |
|---|---|---|---|---|
| A. Cost of Establishment | | | | |
| Planting on secondary forest | | i). Land preparation | | |
| Labour costs | | | | |
| Land clearing | 12 | 4.275 | | 51.3 |
| Felling and chopping big trees | 1 | 6.4125 | | 6.4125 |
| Controlled burning | 2 | 4.275 | | 8.55 |
| Clearing stumps | 1 | 4.275 | | 4.275 |
| Preparation of pegs | 2 | 4.275 | | 8.55 |
| Lining and pegging | 4 | 6.62625 | | 26.505 |
| Other labour costs | | | | |
| Inputs and equipment (if purchased by the farmer) | | | | |
| Machetes | 1 | 6.84 | | 6.84 |
| Other equipment (specify) | | | | |
| ii) Preparation and planting of seedlings | | | | |
| Labour costs | | | | |
| Setting up nursery | 4 | 4.275 | | 17.1 |
| Care of cocoa seedlings | 10 | | | |
| (up to 6 months) | | 3.63375 | | 36.3375 |
| Holing/planting of plantain suckers | 5 | 4.275 | | 21.375 |
| Holing for planting cocoa seedlings | 5 | 3.63375 | | 18.16875 |
| Carting of cocoa seedlings | 8 | | | |
| (average distance of 2 km) | | 2.1375 | | 17.1 |

| | | | |
|---|---|---|---|
| Planting of cocoa seedlings | 5 | 2.565 | 12.825 |
| Other labour costs: | | | |
| fertilizer application | | | |
| Inputs and equipment | | | |
| Top soil | 1 | 34.2 | 34.2 |
| Bamboos and palm fronds | | | |
| Polyethylene bags for nursery | 1500 | 0.0171 | 25.65 |
| Planting material: hybrid pods | 50 | 0.342 | 17.1 |
| Planting material: plantain suckers | 500 | 0.0855 | 42.75 |
| Fertilizer | | | |
| Type a: sulphate of ammonia | | | |
| Type b: | Type c: | | |
| Other equipment: Earth chisel | 1 | 8.55 | 8.55 |
| Total costs per hectare (a) | | | 363.58875 |

| | | | |
|---|---|---|---|
| Labour costs | | | |
| Weeding | 12 | 4.275 | 51.3 |
| Spraying :Pest control | 3 | 8.55 | 25.65 |
| Spraying : Disease control | 4 | 6.4125 | 25.65 |
| Pruning :shade trees | 8 | | |
| (Sanitation, chupon, canopy) | | 4.275 | 34.2 |
| Thinning :shade trees | 6 | 4.275 | 25.65 |
| Pruning :cocoa trees | 6 | 4.275 | 25.65 |
| Thinning :cocoa trees | 4 | 4.275 | 17.1 |
| Fertilizer application | 1 | 5.13 | 5.13 |
| Mistletoe control | 8 | 6.4125 | 51.3 |
| Other labour costs | | | |
| Inputs and equipment | | | |
| Cutlass | 2 pieces | 10.26 | 20.52 |
| Weedicides | | | |
| Insecticides | 3 litres | 8.55 | 25.65 |
| Fungicides | 6 sachets | 4.275 | 25.65 |
| Fertilizer | 1x50Kg | 67.17735 | 67.17735 |
| Mistblower (hiring) | 2x3 | 8.55 | 51.3 |
| Pneumatic Sprayer (hiring) | 2x6 | 3.42 | 41.04 |
| Axe | | | |

| | | | | |
|---|---|---|---|---|
| Other equipment | | | | |
| Knapsack | 1 | 25.65 | 5 years | 25.65 |
| Wellingtonboots | 1 | 17.1 | 3 years | 17.1 |
| Protective Clothes | | | 3 years | |
| NB. Cost of one hectare of land = 940.5 Ghana cedis | | | | |
| PRODUCTION COST | | | | |
| | | i). | Maintenance | |
| ii). Harvesting | | | | |
| Labour | | | | |
| Plucking of Pods | 4 | 2.565 | | 10.26 |
| Gathering and Heaping | 5 | 1.71 | | 8.55 |
| Pod-breaking and Fermenting | 9 | 2.9925 | | 26.9325 |
| Other Labour costs | | | | |
| Harvesting and carting plantain bunches | 6 | 2.1375 | | 12.825 |
| Inputs and Equipment | | | | |
| Baskets | 5 | 4.275 | 2 years | 21.375 |
| Harvesting Hooks | 1 | 4.275 | 5 years | 4.275 |
| Machetes | 2 | 3.42 | 1 year | 6.84 |
| Other equipment: sharpening stones | 1 | 4.275 | 1 year | 4.275 |
| iii). Post Harvest | | | | |
| Labour | | | | |
| Carting of fermented beans | 9 | 2.1375 | | 19.2375 |
| Drying | 2 x 14 days | 1.2825 | | 35.91 |
| Erecting platform | 2 | 2.1375 | | 4.275 |
| Bagging and carting | 3 | 2.1375 | | 6.4125 |
| Inputs and equipment Drying mat | 2 | 85.5 | 5 years | 171 |
| Total current costs (b) | | | | 867.88485 |
| EXPECTED COCOA YIELD (kg/ha) | 633.47 | 5.16 | | 3268.7052 |
| PLANTAIN YIELD (kg/ha) | 1225 | 0.67 | | 820.75 |

Source: Field Data, 2014

C. Partial Budget Analysis Ha-1 for a Change from full sun cocoa production practice to High shade level of cocoa agroforestry production practice

| Item<br>Additional cost (A1) | GH¢/Ha | Item<br>Reduced cost (B1) | GH¢/Ha |
|---|---|---|---|
| Spraying :Pest control | 20 | Felling and chopping big trees | 135 |
| Spraying : Disease control | 30 | Clearing stumps | 70 |
| Pruning :shade trees (Sanitation, chupon, canopy) | 80 | Care of cocoa seedlings (up to 6 months) | 15 |
| Thinning :shade trees | 60 | Holing for planting cocoa seedlings | 7.5 |
| Pruning :cocoa trees | 40 | Carting of cocoa seedlings ( average distance of 2km) | 10 |
| Thinning :cocoa trees | 30 | Planting of cocoa seedlings | 5 |
| Mistletoe control | 75 | Weeding | 70 |

| | | | |
|---|---|---|---|
| Insecticides | 20 | Weedicides | 15 |
| Fungicides | 28 | Protective Clothes | 15 |
| Mistblower (hiring) | 40 | Total Reduced cost (B1) | 342.5 |
| Pneumatic Sprayer (hiring) | 40 | | |
| Plucking of Pods | 6 | | |
| Gathering and Heaping | 8 | | |
| Pod-breaking and Fermenting | 21 | | |
| Baskets | 10 | | |
| Carting of fermented beans | 5 | | |
| Drying mat | 100 | | |
| Total Additional cost (A1) | 613 | | |
| Reduced income (A2) | | Additional income (B2) | |
| none | 0 | Revenue from increased cocoa yield | 682.61 |
| Total reduced income (A2) | 0 | Total additional income (B2) | 682.61 |
| Column total (A1+A2) | 613 | Column total (B1+B2) | 1025.11 |
| Net income ((B1+B2)-(A1+A2)) | | | 412.11 |

Source: Data analysis, 2014

D. Private Cost Benefit Analysis – High Shade Level

| YEAR | Investment cost GH¢/Ha | Operational cost GH¢/Ha | Total cost GH¢/Ha | Total Revenues GH¢/Ha | Net-Revenue GH¢/Ha | Discount factor 30% | Discounted Net-Revenue GH¢/Ha |
|---|---|---|---|---|---|---|---|
| 0 | 1792.5 | 0 | 1792.5 | 0 | -1792.5 | 1 | - 1792.5 |
| 1 | | 182.7 | 182.7 | 703.5 | 520.8 | 0.769231 | 400.6154 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | 203.7 | 203.7 | 820.75 | 617.05 | 0.591716 | 365.1183 |
| 3 | 403.2 | 403.2 | 469 | 65.8 | 0.455166 | 29.94993 |
| 4 | 1360.8 | 1360.8 | 1488.48 | 127.68 | 0.350128 | 44.70398 |
| 5 | 1140.3 | 1140.3 | 1488.48 | 348.18 | 0.269329 | 93.77474 |
| 6 | 1145.55 | 1145.55 | 1488.48 | 342.92 | 0.207176 | 71.04674 |
| 7 | 1119.3 | 1119.3 | 1488.48 | 369.18 | 0.159366 | 58.8347 |
| 8 | 1198.05 | 1198.05 | 2147.46 | 949.41 | 0.122589 | 116.3878 |
| 9 | 1334.55 | 1334.55 | 2147.46 | 812.91 | 0.0943 | 76.65715 |
| 10 | 1215.9 | 1215.9 | 2147.46 | 931.56 | 0.072538 | 67.57369 |
| 11 | 1210.65 | 1210.65 | 2147.46 | 936.81 | 0.055799 | 52.27271 |
| 12 | 1215.9 | 1215.9 | 2147.46 | 931.56 | 0.042922 | 39.98443 |
| 13 | 1221.15 | 1221.15 | 2147.46 | 926.31 | 0.033017 | 30.58392 |
| 14 | 1452.15 | 1452.15 | 2147.46 | 695.31 | 0.025398 | 17.65924 |
| 15 | 1189.65 | 1189.65 | 2147.46 | 957.81 | 0.019537 | 18.7124 |
| 16 | 1215.9 | 1215.9 | 2147.46 | 931.56 | 0.015028 | 13.99966 |
| 17 | 1210.65 | 1210.65 | 2147.46 | 936.81 | 0.01156 | 10.82966 |
| 18 | 1247.4 | 1247.4 | 2147.46 | 900.06 | 0.008892 | 8.003712 |
| 19 | 1404.9 | 1404.9 | 2147.46 | 742.56 | 0.00684 | 5.079352 |
| 20 | 1236.9 | 1236.9 | 2147.46 | 910.56 | 0.005262 | 4.791173 |
| 21 | 1189.65 | 1189.65 | 2147.46 | 957.81 | 0.004048 | 3.876763 |
| 22 | 1215.9 | 1215.9 | 2147.46 | 931.56 | 0.003113 | 2.900397 |
| 23 | 1242.15 | 1242.15 | 2147.46 | 905.31 | 0.002395 | 2.168206 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 24 | 1431.15 | 1431.15 | 2147.46 | 716.31 | 0.001842 | 1.319657 |
| 25 | 1189.65 | 1189.65 | 2147.46 | 957.81 | 0.001417 | 1.357363 |
| 26 | 1236.9 | 1236.9 | 2031.10 | 794.20 | 0.00109 | 0.865771 |
| 27 | 1189.65 | 1189.65 | 2031.10 | 841.45 | 0.000839 | 0.705599 |
| 28 | 1247.4 | 1247.4 | 2031.10 | 783.70 | 0.000645 | 0.505518 |
| 29 | 1425.9 | 1425.9 | 2031.10 | 605.20 | 0.000496 | 0.300291 |
| 30 | 1215.9 | 1215.9 | 17781.10 | 16565.2 | 0.000382 | 6.322606 |
| NPV | -245.599 | | | | | |
| IRR | 26.6669% | | | | | |

Source: Data Analysis, 2014

E. Social Cost-Benefit Analysis- High Shade Level

| YEAR | Investment cost GH¢/Ha | Operational cost 18% | Total cost GH¢/Ha | Total Benefits GH¢/Ha | Net-Benefit GH¢/Ha | Discount factor | Discounted Net-Benefit GH¢/Ha |
|---|---|---|---|---|---|---|---|
| 0 | 1304.0887 | 0 | 1304.08 | 0 | -1304.09 | 1 | -1304.09 |
| 1 | | 88.877 | 88.8772 | 703.5 | 614.6228 | 0.847458 | 520.8667 |
| 2 | | 106.83 | 106.832 | 820.75 | 713.9178 | 0.718184 | 512.7246 |
| 3 | | 223.54 | 223.539 | 469 | 245.4603 | 0.608631 | 149.3947 |
| 4 | | 777.00 | 777.002 | 2265.649 | 1488.647 | 0.515789 | 767.8275 |
| 5 | | 588.48 | 588.475 | 2265.649 | 1677.174 | 0.437109 | 733.1084 |
| 6 | | 592.96 | 592.963 | 2265.649 | 1672.686 | 0.370432 | 619.6155 |
| 7 | | 570.52 | 570.520 | 2265.649 | 1695.129 | 0.313925 | 532.1436 |
| 8 | | 610.92 | 610.918 | 3268.701 | 2657.782 | 0.266038 | 707.0716 |
| 9 | | 754.56 | 754.558 | 3268.701 | 2514.142 | 0.225456 | 566.8287 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | 668.89 | 668.886 | 3268.701 | 2599.815 | 0.191064 | 496.7322 |
| 11 | 664.40 | 664.397 | 3268.701 | 2604.303 | 0.161919 | 421.6863 |
| 12 | 668.89 | 668.886 | 3268.701 | 2599.815 | 0.13722 | 356.7453 |
| 13 | 673.38 | 673.375 | 3268.701 | 2595.326 | 0.116288 | 301.8046 |
| 14 | 870.88 | 870.880 | 3268.701 | 2397.821 | 0.098549 | 236.3027 |
| 15 | 646.44 | 646.442 | 3268.701 | 2622.258 | 0.083516 | 219.0006 |
| 16 | 668.89 | 668.886 | 3268.701 | 2599.815 | 0.070776 | 184.0053 |
| 17 | 664.40 | 664.397 | 3268.701 | 2604.303 | 0.05998 | 156.2059 |
| 18 | 668.89 | 668.886 | 3268.701 | 2599.815 | 0.05083 | 132.1497 |
| 19 | 830.48 | 830.481 | 3268.701 | 2438.22 | 0.043077 | 105.0303 |
| 20 | 686.84 | 686.841 | 3268.701 | 2581.86 | 0.036506 | 94.25242 |
| 21 | 646.44 | 646.442 | 3268.701 | 2622.258 | 0.030937 | 81.12474 |
| 22 | 668.89 | 668.886 | 3268.701 | 2599.815 | 0.026218 | 68.16136 |
| 23 | 691.24 | 691.235 | 3268.701 | 2577.465 | 0.022218 | 57.2673 |
| 24 | 852.93 | 852.925 | 3268.701 | 2415.776 | 0.018829 | 45.48712 |
| 25 | 646.44 | 646.442 | 3268.701 | 2622.258 | 0.015957 | 41.84324 |
| 26 | 686.84 | 686.841 | 3091.587 | 2404.745 | 0.013523 | 32.51898 |
| 27 | 646.44 | 646.442 | 3091.587 | 2445.144 | 0.01146 | 28.02143 |
| 28 | 668.89 | 668.886 | 3091.587 | 2422.7 | 0.009712 | 23.529 |
| 29 | 848.44 | 848.436 | 3091.587 | 2243.15 | 0.00823 | 18.46206 |
| 30 | 646.44 | 646.442 | 177654.1 | 177007.6 | 0.006975 | 1234.616 |
| NPV | 8140.439 | | | | | |
| IRR | 64.1855% | | | | | |

Source: Data Analysis, 2014

F. Stumpage Fees Review (Effective March 1, 2014)
High Demand- Stumpage Rtate 20%

| Scientific Name | Trade Name | Stumpage Fee GH₵ |
|---|---|---|
| *Amphimas spp* | Yaya | 8.75 |
| *Antiaris Africana* | Chenchen | 5.98 |
| *Celtis spp* | Essa | 8.75 |
| *Cylicodiscus gabonensis* | Denya | 11.67 |
| *Cynometra spp* | Ananta | 10.21 |
| *Dialium aubrevillei* | Duabankye | 5.84 |
| *Erythronphleum guineese* | Potrodom | 7.73 |

Moderate Demand- Stumpage Rtate 10%

| Scientific Name | Trade Name | Stumpage Fee Gh₵ |
|---|---|---|
| *Afzelia Africana/bella* | Papao | 38.81 |
| *Albizzia ferruginea* | Awiemfosamina | 16.63 |
| *Canarium schweinfurthii* | Bediwonua | 21.59 |
| *Ceiba pentandra* | Onyina | 10.50 |
| *Chrysophyllum albidum* | Akasa | 28.01 |
| *Daniellia ogea* | Hyedua | 16.92 |
| *Disternonanthus benthamianus* | Ayan | 26.26 |
| *Entandophragma angolense* | Edinam | 21.59 |
| *Guarea spp* | Guarea | 25.09 |
| *Heritiera utilis* | Niangon | 32.15 |
| *Lophira alata* | Kaku/ekki | 21.59 |
| *Mansonia altissima* | Mansonia | 33.55 |
| *Pterygota macrocarpa* | Koto | 25.68 |
| *Rhodognaphalon brevicuspe* | Bombax | 13.42 |
| *Terminalia ivorensis* | Emeri | 21.59 |
| *Terminalia superba* | Ofram | 16.92 |
| *Triplochiton scleroxylon* | Wawa | 18.09 |
| *Turreanthus africanus* | Avodire | 21.59 |

Low Demand- Stumpage Rtate 5%

| Scientific Name | Trade Name | Stumpage Fee Gh₵ |
|---|---|---|
| *Aningeria robusta* | Asanfina | 56.02 |
| *Dalbergia melanoxylon* | African blackwood | 74.58 |
| *Entandophragma candollei* | Candollei | 43.13 |
| *Entandophragma cylindricum* | Sapele | 65.36 |
| *Entandophragma utile* | Utile | 67.69 |
| *Guibourtia ehie* | Hyedua(black) | 73.53 |

| | | |
|---|---|---|
| *Khaya grandifolia/anthotheca* | African | 43.18 |
| *Khaya ivorensis* | African mahogany | 67.58 |
| *Lovoa trichiloides* | African walnut | 44.35 |
| *Milicia excelsa/regia* | Odum | 74.70 |
| *Nauclea diderrichii* | Kussia | 42.02 |
| *Pericopsis elata* | Afrormosia | 99.79 |
| *Pterocarpus erinaceous* | Rosewood | 52.64 |
| *Tieghemella heckelii* | Makore | 61.86 |

| | | |
|---|---|---|
| *Gilbertiodendron spp* | Tetekon | 11.67 |
| *Mammea Africana* | Bompagya | 8.46 |
| *Morus mesozygia* | Wonton | 11.67 |
| *Nesofordonia papaverifera* | Danta | 10.80 |
| *Petersianthus spp* | Essia | 6.42 |
| *Piptadeniastrum africanum* | Dahoma | 9.19 |
| *Pycnanthus angolensis* | Otie | 6.71 |
| *Sterculia rhinopetala* | Wawabima | 8.75 |
| *Stormbosia pustulata* | Afina | 8.75 |
| | Others | 6.03 |

Source: Forestry Commission of Ghana (2014)

**A SURVEY ON ECONOMIC PERFORMANCE OF COCOA AGROFORESTRY IN GHANA**



Questionnaire Number: …………… Name of enumerator................................................

Date (dd/mm/yy): ………........................... Name of Village..........................................

Name of District............................................ Name of Region............................................

Name of Farmer: ........................................ Mobile phone number: ....................................

**SECTION A: Personal and Household Characteristics**

**A1: Personal characteristics**

1. Age of farmer (years): ..........................................................................................
2. Gender: 1. Male 2. Female
3. What is your level of formal Education? 1-No formal education

   2-Basic (Primary/JHS/Middle) 3 -Secondary 4-Vocational/technical/commercial

   5-Tertiary (Training college/Polytechnic/university)

4 Ethnic background (Tribe): 1- Akan 2- Ga- Adangbe 3- Ewe 4- Dagomba

5- Gonja 6-Frafra 7- Grushie 8 -Other(specify)..............................

5 What is your marital status: 1.Single 2. Married 3. Separated 4. Divorced

6 What is your residence status: 1- Indigene (Native) 2- Migrant (Permanent)

3- Migrant (Transient)

**A2: Household characteristics**

7 Are you a household Head? 1- Yes 2- No

8 What is your number of children below 15 years? .......................................................
9 What is your household size including yourself? .......................................................

10. Do you receive advice on your cocoa farm from extension agent? 1. Yes, 2.No

(i) If yes, what type of agricultural extension services do you receive?..................
..............................................................................................................................

(i) If yes, how often do you receive technical advice from extension agents? (per year)
..........................................................

11. Apart from extension agents where do you get your technical advice from?

1. Researchers 2. From media (TV, radio, newspapers)

3. Other farmers/friends 4. Other (specify).......................

12. Did you access credit to support your cocoa farming in 2013? 1. Yes 2. No

a. If yes, did you receive the credit? 1. Yes 2. No

(i) If yes, what were the source(s) of the credit received? 1. Banks 2. NGO"s

3. Family and friends 4. Cooperatives 5. Others (specify)..................

(ii) If yes, what was the form of credit received?

1. Cash [ ] 2.Farming input [ ] 3. Both cash and inputs [ ]

4. Other (specify)...........................

(iii) If farm input, mention them..........................................................................................

(iv) If yes, complete the table below

| | **Credit received in 2013** |
|---|---|
| Cash | |
| Farming inputs | |
| Other(specify) | |
| | |

(v) If no, why? 1. Not available 2. Interest rate is high 3. Don‟t know
4. Other reasons (specify)........................................................................

13. Do you belong to any Farmer Based-Organisation (FBO)? 1. Yes 2. No

(i) If yes, which FBO do you belong to?................................

14. Did you receive assistance from the FBO towards cocoa production?

1-Yes, 2-No

(i) If yes, what assistance did you receive from the FBO towards cocoa production?
..........................................................................

**SECTION B: Plot-level characteristics**

How many plots do you have? …………………………………..

| | Questions | Response | |
|---|---|---|---|
| | | Plot 1 | Plot 2 |
| 15 | What is the size of your cocoa farm (acres)? | | |
| 16 | How old is your cocoa farm? | | |
| 17 | How many years have you been harvesting from your cocoa farm? | | |
| 18 | What type of vegetation do you have on your farm? | | |
| 19 | What is the slope of your land? | | |
| 20 | What is the distance from home to farm? | | |

21. Do you invest in soil improvement strategies?

a. Yes b. No

i) if yes, which of the strategies do you engage in

a. compost b. mulching c. other (specify)…………………………………..

**SECTION C: Perceptions of farmers on cocoa agroforestry systems**

| | Perception statement | Yes | No |
|---|---|---|---|
| | **Perceptions on soil fertility** | | |
| 19 | Shade trees in cocoa increase the nutrient content of the soil. | | |
| 20 | Shade trees increase the moisture content of the soil | | |
| 21 | Soils under cocoa agroforests are more fertile than soils with no shade in cocoa farms. | | |
| 22 | Cocoa trees under cocoa agroforestry systems require less fertilizer. | | |
| | **Perceptions on biodiversity** | | |
| 23 | Cocoa agroforests have higher levels of biodiversity than no shade cocoa technology. | | |
| 24 | Agroforestry systems conserve natural resources and maintains ecosystem. | | |
| 25 | Diversity of trees enhances the availability of medicinal plants. | | |
| 26 | Cocoa trees under agroforestry technology have lower incidence of pest than no shade cocoa technology. | | |
| 27 | Cocoa trees under agroforestry technology have lower incidence of diseases than no shade cocoa technology | | |
| 28 | Pest and diseases are biologically controlled under cocoa agroforestry system. | | |
| | **Perception on yields** | | |
| 29 | Cocoa agroforestry systems give sustainable yield than no shade cocoa technology. | | |
| 30 | Lower shade tree density increases cocoa yield | | |
| 31 | Higher shade tree density increases cocoa yield | | |
| 32 | Higher cocoa tree density increases cocoa yield | | |
| 33 | The older the age of shade trees the higher the cocoa yield. | | |
| 34 | The lower the age of shade trees the higher the cocoa yield. | | |
| 35 | Diversity of plants increases cocoa yield | | |
| 36 | Variety of cocoa affect the yield of cocoa | | |
| | **Perception on income** | | |
| 37 | Cocoa agroforestry assist farmers to diversify their production | | |
| 38 | Cocoa agroforestry systems help farmers to grow more crops on the land. | | |
| 39 | Adoption of cocoa agroforestry systems increases income of cocoa farmers. | | |

| | | | |
|---|---|---|---|
| 40 | Cocoa agroforestry systems reduce the costs of management technologies on cocoa farms. | | |

**SECTION D: Cocoa agroforestry production (after 3years)**

**D1: Labour Input in 2013**

| **Family labour input( per acre)** | **Plot 1** | | | | **Plot 2** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Major season** | | **Minor season** | | **Major season** | | **Minor season** | |
| | No. of ppl | No. of days | No. of ppl | No. of days | No. of ppl | No of days | No. of ppl | No. of days |
| 1st weeding/pruning | | | | | | | | |
| 2nd weeding/pruning | | | | | | | | |
| Fertilizer Application | | | | | | | | |
| Insecticides Application | | | | | | | | |
| Fungicides Application | | | | | | | | |
| Pruning of shade trees | | | | | | | | |
| Thinning of shade trees | | | | | | | | |
| Thinning of cocoa trees | | | | | | | | |
| Pruning of cocoa trees | | | | | | | | |
| Mistletoe control | | | | | | | | |
| Plucking of cocoa beans from the trees | | | | | | | | |
| Husk removal | | | | | | | | |
| Transportation of cocoa beans from the farm | | | | | | | | |
| Drying | | | | | | | | |
| Erecting platform | | | | | | | | |
| Bagging and carting | | | | | | | | |
| Others (Specify) | | | | | | | | |

| Hired labour input (per acre) | Plot 1 | | | | | | Plot 2 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Major season | | | Minor season | | | Major season | | | Minor season | | |
| | No. of ppl | No. of days | Cost GhȻ | No. of ppl | No. of days | Cost GhȻ | No. of ppl | No. of days | Cost GhȻ | No. of ppl | No. of days | Cost GhȻ |
| 1st weeding/pruning | | | | | | | | | | | | |
| 2nd weeding/pruning | | | | | | | | | | | | |
| Fertilizer Application | | | | | | | | | | | | |
| Insecticides Application | | | | | | | | | | | | |
| Fungicides Application | | | | | | | | | | | | |
| Pruning of shade trees | | | | | | | | | | | | |
| Thinning of shade trees | | | | | | | | | | | | |
| Thinning of cocoa trees | | | | | | | | | | | | |
| Pruning of cocoa trees | | | | | | | | | | | | |
| Mistletoe control | | | | | | | | | | | | |
| Plucking of cocoa beans from the trees | | | | | | | | | | | | |
| Husk removal | | | | | | | | | | | | |
| Transportation of cocoa beans from the farm | | | | | | | | | | | | |
| Drying | | | | | | | | | | | | |
| Erecting platform | | | | | | | | | | | | |
| Bagging and carting | | | | | | | | | | | | |
| Others (Specify) | | | | | | | | | | | | |

**D2: Other variable inputs in 2013**

| | Plot 1 | | | Plot 2 | | |
|---|---|---|---|---|---|---|
| **Inputs** | **Frequency (year)** | **Qty** | **Unit cost (GHC)** | **Frequency (year)** | **Qty** | **Unit cost (GHC)** |
| Weedicide (litres) | | | | | | |
| Fertilizer (bags) | | | | | | |
| Fungicide (litres) | | | | | | |
| Insecticide (litres) | | | | | | |
| Cutlass | | | | | | |
| Hoe | | | | | | |
| Mistblower (hiring) | | | | | | |
| Pruner | | | | | | |
| Pneumatic Sprayer | | | | | | |
| Chisel | | | | | | |
| Drying mat | | | | | | |
| Fermentation | | | | | | |
| Sickle | | | | | | |
| Axe | | | | | | |
| Basket | | | | | | |
| knapsack | | | | | | |
| Wellington boot | | | | | | |
| Protective clothes | | | | | | |
| Other (specify) | | | | | | |

**Section E: Output from cocoa production**

a) How many bags of cocoa have you harvested during the following years?

| | Plot 1 | | Plot 2 | |
|---|---|---|---|---|
| Year | Major harvesting season | Minor harvesting season | Major harvesting season | Minor harvesting season |

| | Output (65kg bag) | Output (65kg bag) | Output (65kg bag) | Output (65kg bag) |
|---|---|---|---|---|
| 2011 | | | | |
| | | | | |
| | | | | |
| 2012 | | | | |
| | | | | |
| | | | | |
| 2013 | | | | |
| | | | | |
| | | | | |

(b) Which producer buying company do you normally sell your cocoa to? ..............................

**SECTION F: Cocoa agroforestry systems**

**F1: Adoption of agroforestry systems**

| | | **Plot 1** | | **Plot 2** | |
|---|---|---|---|---|---|
| | **Type of cocoa agro forestry system** | **No. of years of adoption** | **No. of shade trees/ acre** | **No. of years of adoption** | **No. of shade trees/ acre** |
| 1 | Low shade (1-3 trees per acre) | | | | |
| 2 | Medium shade (4-7 trees per acre) | | | | |
| 3 | High shade (8 or more trees per acre) | | | | |
| 4 | No shade | | | | |

(ii) What shade trees do you have on your cocoa farm?

| Plots | Local name | Uses to the farmer* |
|---|---|---|
| Plot 1 | | |
| | | |
| | | |
| Plot 2 | | |
| | | |
| | | |

*The uses could be: 1. Medicine 2. Fertilizer 3. Shade 4. Food 5. Timber 6. Other (Specify)

14. Did you plant the shade trees yourself? 1. Yes 2.No

(i) If no, how was the shade trees established? ..................................................................

1. Natural growth 2. Planted by another person 3. Other (specify) …………………

**SECTION F2: Constraints to adoption of cocoa agroforestry systems** 46. Please tick the constraints to adoption of cocoa agroforestry systems

| | Constraint | Tick |
|---|---|---|
| | **Local customary practices** | |
| i. | Incidence of bushfires | |
| ii. | Grazing by livestock during the dry season | |
| iii. | Seasonal occurrence of plant pest | |
| | **National Policy** | |
| iv. | Absence of perennial private right over land | |
| v. | logging regulations/ procedures problems | |
| vi. | Tree ownership right problems | |
| vii. | Inadequate compensation for destroyed cocoa trees | |
| | **Training** | |
| viii. | Lack of training on management of agroforestry trees. | |
| ix. | Difficulty in managing the shade tree by cocoa farmers. | |
| | **Seed and Germplasm** | |
| x. | Inadequate access to quality seeds and seedlings | |
| xi. | Quality seeds and seedlings can only be purchased at few vantage points. | |
| xii. | Seedling sellers are not closed to farmers‟ vicinity. | |
| xiii. | Seedlings are not affordable. | |
| | **Poor information dissemination about the technology** | |
| (xiv) | Benefits of the technology to farmers are not well communicated. | |
| (xv) | Benefits of the technology to community are not well Communicated. | |
| | **Human Resource capacity** | |
| (xvi) | High labour demand for tree pruning | |
| (xvii) | Lack of agricultural extension agent(AEA) | |
| (xviii) | High labour requirement in establishment of shade tree nursery | |
| (xix) | High labour requirement in the maintenance of the shade tree nursery | |
| | **Others(specify)** | |
| | | |

F3: Establishment of Cocoa Agro forests (1-3years)

**20. COSTS OF INPUTS AND LABOUR USE FOR COCOA AGROFORESTRY (2013)**
What is the size of your cocoa farm (1-3 years)? .......................acres

| | Year 1 | | Year 2 | | Year 3 | |
|---|---|---|---|---|---|---|
| | **Qty** | **Unit cost** | **Qty** | **Unit cost** | **Qty** | **Unit cost** |
| **Inputs** | | | | | | |
| Land | | | | | | |
| Cutlass | | | | | | |
| Hoe | | | | | | |
| Chisel (soso) | | | | | | |
| **Labour input** | | | | | | |
| Land clearing | | | | | | |
| Felling and chopping big trees | | | | | | |
| Controlled burning | | | | | | |
| Clearing stumps | | | | | | |
| Preparation of pegs | | | | | | |
| Lining and pegging | | | | | | |
| Setting up nursery | | | | | | |
| Care of seedlings (up to 6 months) | | | | | | |
| Holing/planting of plantain suckers | | | | | | |
| Holing for planting seedlings | | | | | | |
| Carting of seedlings ( average distance of 2 km) | | | | | | |
| Planting of seedlings | | | | | | |
| Planting cassava | | | | | | |
| Planting cocoyam & yam | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Transplanting/direct sowing of cocoa | | | | | | |
| Planting tree seedlings | | | | | | |
| 1st weeding | | | | | | |
| 2nd weeding | | | | | | |
| Harvesting maize | | | | | | |
| Harvesting cassava | | | | | | |
| Harvesting cocoyam | | | | | | |
| Harvesting yam | | | | | | |
| Haulage of maize | | | | | | |
| Dehusking | | | | | | |
| Shelling | | | | | | |
| Crib construction | | | | | | |
| Top soil | | | | | | |
| Bamboos and palm fronds | | | | | | |
| Polyethylene bags for nursery | | | | | | |
| Planting material: hybrid pods | | | | | | |
| Fertilizer application | | | | | | |
| Maize seed | | | | | | |
| Plantain sucker | | | | | | |
| Cocoyam seeds | | | | | | |
| Cassava sticks | | | | | | |
| Shade trees seedlings | | | | | | |
| Maize sacks | | | | | | |
| Storage chemicals | | | | | | |
| Transportation to market | | | | | | |
| Other cost | | | | | | |

**Section G: Non-cocoa components of the cocoa farm**

**G1: Income from food crops (temporary shade (1-3 years))**

| | **Year 1** | | **Year 2** | | **Year 3** | |
|---|---|---|---|---|---|---|
| | **Output** | **Unit cost** | **Output** | **Unit cost** | **Output** | **Unit cost** |
| Maize (bags) | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Plantain | | | | | | |
| Cassava (bags) | | | | | | |
| Cocoyam (bags) | | | | | | |
| Yam | | | | | | |
| Others | | | | | | |
| | | | | | | |