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The Feasibility of REDD+ Implementation in Ghana: A Case of Three Farming Communities

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Abstract:

Forest plays an important role in regulating the earth's climate. However, this resource is under a great threat in Ghana. Reducing emission from deforestation and degradation, conservation of forest carbon stocks, sustainable management of forests, enhancement of forest carbon stocks (REDD+) is one of the latest initiatives the country is embarking on to reverse this menace. The paper examines the feasibility of its implementation in Ghana by assessing the opportunity cost of farmers if they decide to engage in REDD+ projects. Thus, the aim of the paper is, to evaluate the cost and benefits of REDD+ implementation in Ghana and how the reducing emission goal could be attained. To do this, the profitability of the current land use practices and its associated opportunity cost of three communities in the central region of Ghana were estimated. Also, profits were calculated using enterprise budget method and the opportunity costs of the land use per hectare by the discounted cash flow analysis method. The results show that the current land use practice provides a more attractive option than any potential REDD+ project. This notwithstanding, the paper shows REDD+ can be a complementary policy in tackling forest degradation in Ghana.

Keywords: Carbon Stocks, Farming Practices, Ghana, Opportunity costs, REDD+

1.0 Introduction:

Forests play an important role in the protection of the earth. Conserving the forest could avert the rapid change of the world's climate. However, forest has become vulnerable to excessive human exploitation and a threat to climate change due to high rate of deforestation and forest degradation. Deforestation has been identified as the second largest anthropogenic source of carbon dioxide to the atmosphere after fossil fuel combustion (Mbow et al., 2012). It is a significant source of emissions accounting for nearly 17% of all the Greenhouse gas (GHG) emissions (IPCC, 2007) and this is more than the emissions that emanate from the world's transport sector (CIFOR, 2014).

Ghana, a major culprit of this menace has an annual deforestation rate of 2.19%, corresponding to an average annual forest loss of 115,000ha (FAO, 2010). Between 1990-2005 Ghana lost about 1.9million hectares of forest representing 26% of its forest cover (Damona and Sahs, 2009). This is mainly as a result of indiscriminate logging, bush burning and conversion of forest to farmland (i.e. improper farming practices). Tackling deforestation and degradation issues has not been a simple task for the Government of Ghana due to the complexity of the causes of deforestation in Ghana. Notwithstanding, the Government has embarked on a number of reforestation programmes like the National Forest Plantation Development Programme and the Taungya system (Forestry Commission, 2013). The latest initiative being the international REDD+ readiness process through the World Bank's Forest Carbon Partnership Facility (FCPF), which aims at creating a capacity to fully engage in and utilize the reducing emissions from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forests, enhancement of forest carbon stocks (REDD+) mechanism to address climate change adaptation and mitigation.

To take part in REDD+ initiative in Ghana would mean to give up the regular farming activities (opportunity cost) which are economically beneficial. According to Pirard (2008) the opportunity cost (OC) of reducing tropical deforestation is very low as compared to the emission reductions in the industrialised countries as proposed by prominent advocators like Stern (2009) or Chomitz et al. (2006). However, proponents for developing countries are at the same time claiming that the OC for reducing tropical deforestation is very high in terms of economic development. These controversies would make negotiating for compensation for emission reduction with regards to tropical deforestation highly complicated since higher OC could undermine the main focus of a project. Because of the relevance of OC to REDD+, most studies have focused on estimating the OC a country is likely to incur for engaging in REDD+.

The focus of this study, however, will distinctively look into the cost of implementing REDD+ in Ghana to the individual participant and how to entice them to fully participate in order to ensure longevity of the project. Thus, to determine if farmers will participate in the REDD+ programme and at what cost will they participate to ensure the permanency of the programme in Ghana. It will estimate the profitability of the various land use practices then later estimate OC. The main target is to know how much to pay to local farmers for them to keep their forest standing and to determine if REDD+ could be permanent in Ghana. Thus the main objective of this research is to evaluate the cost and benefit of REDD+ implementation in Ghana and how it can achieve the reducing emission goal by getting land users (farmers) to fully participate.

The paper is structured as follows: Section 2 describes the methodological issues of the study with respect to the study area, conceptual framework used for the evaluation of the cost and benefits of REDD+ implementation in Ghana, data collection techniques and analytical procedures. The results are presented and discussed in sections 3 and 4 respectively whilst conclusions are given in the last section.

2.0 Materials and Methods:

This section of the paper deals with the methodological issues employed in the study. In the following subsequent chapters of this section, the study area, the conceptual framework, the data collection techniques and analytical procedures employed in this study are discussed.

2.1 Study Area:

Asikuma, Bedum and Odoben, cash crop producing communities in the Asikuma-Odoben-Brakwa District are the communities chosen for the study. This is because of the type of crops grown in the district. They cultivate a variety of cash crops including cocoa, citrus, oil palm with food crops as understory crops and as explicitly stated by the Forest Trends (2009) that agroforestry systems for cocoa production represent promising platforms for carbon sequestration and emissions reductions hence a possible target area for REDD+ implementation in Ghana.

Asikuma-Odoben-Brakwa District is located on the North-central portion of the Central Region of Ghana. The District covers a total Land Area of 884.84km^2 which forms about 9% of the total land area of the Central Region. It is located between latitude 5^o 51” and 5^o 52” North and longitude 1^o 50” and 1^o 5” West (GSS, 2014). The topography is generally low lying ranging between 15m-100m above sea level. It is however undulating with outstanding portions of highlands and swampy areas at certain portions of the low lands. The District is mainly drained by the Ochi River and its tributaries. The soil composition in the area is chiefly loamy and batholiths (MOFA, 2013) which basically support the cultivation of crops like cocoa, pawpaw, oil palm, maize and cassava (GSS, 2014 and MOFA, 2013).

The District lies in the moist semi-equatorial climatic zone with (MOFA, 2013) average monthly temperature of 34^{o}C and 26^{o}C in March and August respectively (GSS, 2014). The average annual rainfall ranges from 120 centimetres in the South East to 200 centimetres in the North West (GSS, 2014). During rainy season the district encounters double maxima rainfall which usually culminates in May-June and September – October. The district has a high relative humidity of 80% during rainy season but falls between 50% and 60% during the dry hot season (GSS, 2014). The vegetation cover of the District is basically semi-deciduous forest and contains commercial trees such as Odum, Mahogany, Wawa and other hard wood (GSS, 2014). The agroforestry systems for cocoa production represent promising platforms for carbon sequestration and emissions reductions hence a possible target area for REDD+ implementation in Ghana (Ofori-Frimpong et al., 2006).

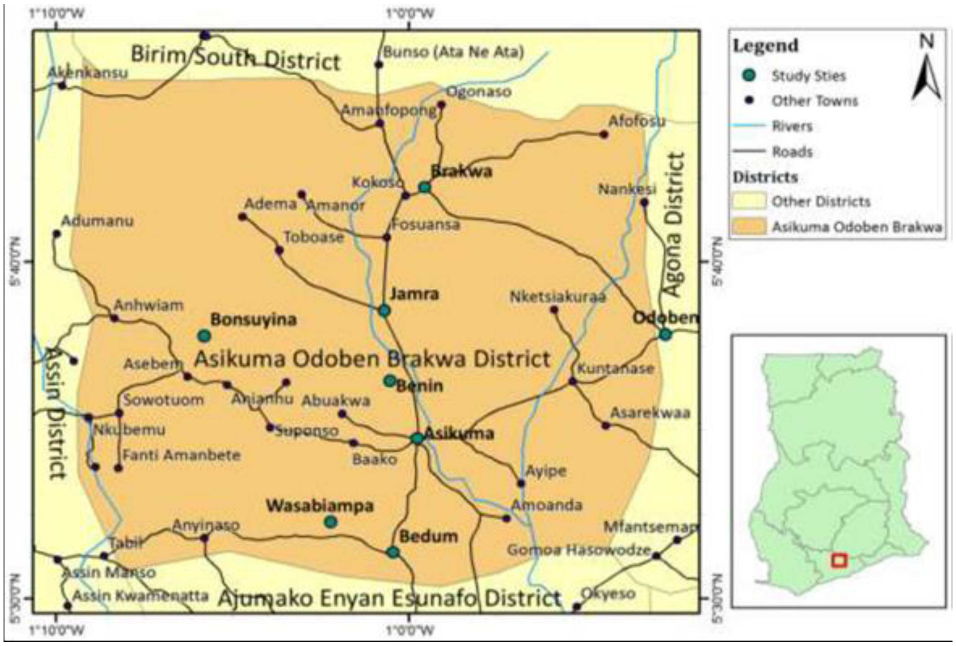

Fig. 1: The Asikuma Odoben Brakwa District
Source: Afriyie (2014).

2.2 Conceptual Framework:

2.2.1 Enterprise Budget (Profitability) Method:

An enterprise budget is a listing of all estimated income and expenses associated with a specific enterprise to provide an estimate of its profitability (Colorado State University, 2008). According to Doye and Sahs (2009) enterprise budgets can be used by landowners to evaluate options before they commit their resources into an investment. It also provides critical input for whole farm planning, including the potential income for a particular farm, the size of farm needed to earn a potential return, and anticipated cash flows during the year (Boardman et al., 2011). Enterprise budgets typically describe the activities that occur within planting and harvest season (World Bank, 2011). For the purpose of this research, cocoa and oil palm are used as enterprise since Smith (1993) aforementioned that the production of one commodity makes up an enterprise. Enterprise budget is used in this research to estimate the profitability of each enterprise or activity in the local currency in a per hectare base (¢/ha). The formula used: $\boldsymbol{\Pi}$ = pq – c; where p = price (¢/ton), q = yield (ton/ha), c = costs (¢/ha) and $\boldsymbol{\Pi}$ = profits.

2.2.2 Net present Value (NPV) Method:

NPV is used to estimate the profitability of a land use or a project over many years (Boardman et al., 2011). NPV takes into account the time-value of money. Since a dollar earned today is more desirable than a dollar earned in the future, the value of the future dollar is discounted by a specific percentage rate. Hence, Wiesemann et al. (2009) indicate that NPV is actuated by discounting all emergent cash flows to the start time of a project. Hanafizadeh and Latif (2011) cited one use of NPV as the comparison of several economic proposals. Beside the use, it is also an appropriate criterion which can be employed to plan projects (Hanafizadeh and Latif, 2011). NPV is the difference between the present value of future cash flows and the initial investment cost. In using the NPV model, a required rate of return which is used to compute 20 the present value of a project's cash inflows and outflows must be used. A project is profitable if the present value is greater than zero, that is, if the present value of the inflows is greater than the present value of the outflows. A project with NPV less than zero must be rejected because it is not profitable (Hansen et al., 2007). In a case where there are two or more projects, the project with the highest NPV must be selected (Boardman et al., 2006, 2011).

The formula for NPV is: $\sum_{t=1}^{n} \frac{(B_t - C_t)}{(1+i)^t}$ Σ (Bt− Ct) (1+i)

tnt=1

Where,

Bt= Landuse benefits accrued over the duration of the project

Ct= Costs incurred over the duration of the project

n = Number of years

i = Discount rate.

The present value of future benefits and costs of the current land use practices need to be known in order to establish whether there will be a net benefit or cost for participating in REDD+ projects, hence the use of the NPV method for the estimation of the costs and benefits in this study.

2.2.3 Discount Rate Method:

Discount rate according to Young (2002) converts flows of costs and benefits over a period into present value. Discount rate is usually used in the discounted cash flow (DCF) analysis which takes into account not just the time value of money, but also the risk or uncertainty of future cash flows (Boardman et al., 2011). Economists use discount rate to account for time while estimating the value of goods and services. For NPV analyses, loan interest rates are usually used. Interest rate is set by the central bank or the government of a country ranging from 10-30% (World Bank, 2011) or it could be derived from the market as well (Boardman et al., 2006). Higher interest rate reverberate an unstable economic conditions and it has a severe effects on investment. A selected discount 21 rate has an impact on the NPV. Figure 1 typifies how with a higher interest rate the NPV profit drastically reduces over time.

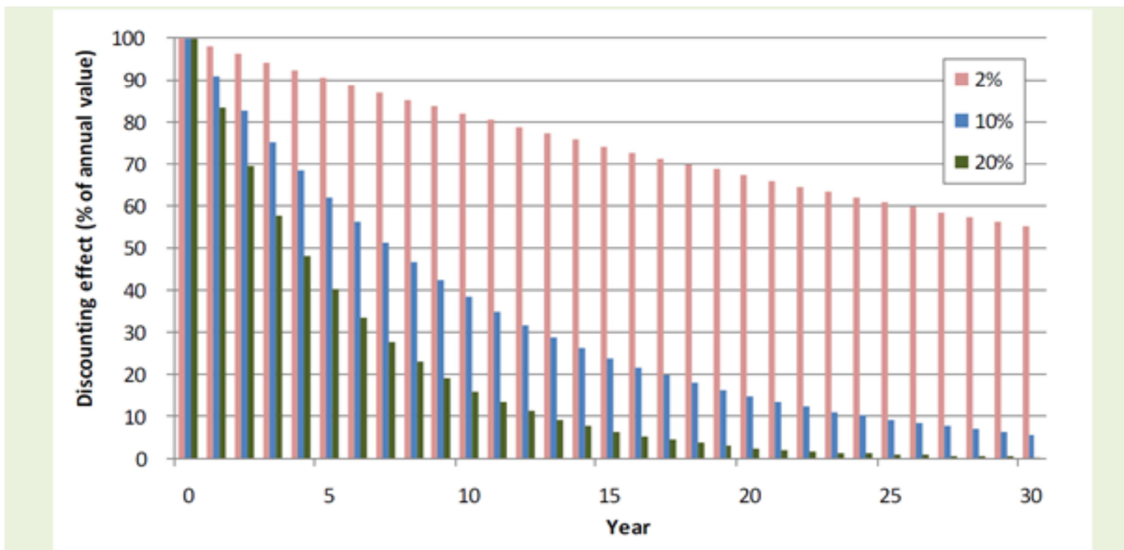

Fig. 2: Effects of discounting on future values (2, 10, 20%). Source: Adopted from World Bank (2011)

According to the World Bank (2011), real interest rate should be used for opportunity cost analysis and Boardman et al., (2006) also suggested the use of real interest rates in conducting cost benefit analysis for public projects. Real interest rate accounts for the effect of inflation while nominal interest rate does not. Analyses which use real rates are crucial as they show the actual increase in value, and how much of a return was just the effect of inflation. Different interest rate representing the cost of borrowing at virtually no risk in Ghana is taken as the discount rate for the NPV calculation. Currently, Ghana's nominal interest rate is very high because of the unstable economic conditions in the country. The figure is set by the central bank's Monetary Policy Committee (MPC). As at the time of gathering this data, the nominal interest rate and the inflationary rate of Ghana were 21% and 16.4% (Trading Economics, 2015) respectively. Since the study employs the use of real interest rate, the expected interest rates and inflation rate for 2020 and 2030 are also used to calculate the interest rates for those years. The expected interest and inflation rate for 2020 and 2030 are 21.85%, 17.23% and 20.15%, 16.82% respectively.

The real interest rate was arrived at by using $r = \frac{i-m}{1+m}$ $i–m1+m$, where *i* is the nominal interest rate, *m* is the inflation rate and *r* is the real interest rate (Boardman et al., 2006). The actual interest rate referred to in this study as the nominal interest rate is 21% where inflation has not been accounted for. Exchange rate as at January 2015 was as follows; 1US$=GH¢3.40.

Cost and benefits are estimated in either real or nominal dollars. Analyst recommends the use of real dollar in predicting future cost and benefits since it takes into account inflation. Boardman et al. (2006) advocate for the use of real dollars in measuring cost and benefit if real discount rates are used. In this study, real dollars are used to measure the cost and benefit since it employs real interest rate. Below is the formula for converting nominal dollars to real dollars:

$real\text{-}\$b = \frac{nominal\text{-}\$_a}{CPI_a}$ $nominal\text{-}\$aCPIa *$ $CPIb$ *where CPI is the Consumer Price Index.*

2.3 Data Collection and Analytical Procedure:

2.3.1 Data Collection:

Three communities were randomly selected from the five major towns in the District. Stratified random sampling was used in arriving at the actual number of farmers that were interviewed. The most common land use practices in the district are cocoa, oil palm, citrus and rubber farming. The crops grown are perennial which have the capacity to store carbon in a woody biomass together with the trees incorporated on the farms. Two crops were chosen for the study: cocoa (*Theobroma cacao*) and oil palm (*Elaeis guineensis*). Farmers engaged in cultivation of these two crops were sampled and interviewed. In all, a total of 75 farmers were interviewed, 37 from Asikuma, 25 from Odoben and 12 from Bedum. The study aimed at interviewing 100 farmers but this was not met as a result of financial constraint. The total population in the district is 89,395 and out of that 48,091 are farmers. The total population of the selected communities 24,622 and out of that 12,391 are from Asikuma, 8,275 from Odoben and 3,956 from Bedum (MOFA, 2013). The interviews were conducted in the three rural communities; however, the offices of the assembly men in the various communities were the first point of call upon arrival in each community to introduce the team and to let our intention known to them. The team included a representative from Forestry Research Institute of Ghana (FORIG).

A semi-structured interview questions were used to collect data from 75 farmers and officials from FORIG and Forestry Commission of Ghana (FC). The one for the officials was designed to gather information concerning the economics of REDD+ in Ghana, opinions concerning the feasibility of REDD+ in Ghana, recommendations and how benefits are going to be shared to ensure permanence. The second set of questions intended for farmers were in three parts. The first part was designed to capture socio-economic data of participants such as name, age, sex, household size, educational and occupational background. The second part included the identification of land use practices and their associated benefits and the third one focused on the cost components associated with the current land use practices. The questions were open-ended, which allowed respondents to express their own views and were recorded. The interviews were conducted on one-on-one bases with the respondent but in a more interactive and discussion form. The interview lasted for about 15 – 20 minutes. The same approach was used in all the three communities, however, personal observation and experiences were also recorded and all led to the collection of the needed qualitative data. Besides, questionnaires were administered to some selected farmers to capture additional information which could not be obtained through interviews.

2.3.2 Analytical Procedure:

The survey questionnaires were analysed using Statistical Package for Social Sciences (SPSS) (version 24, SPSS Inc.) software and excel 2013. The issues that were analysed were socio economic characteristics, farming and livelihood activities, land use practices and likely effect on farmers for adoption of such land use types. Other issues discussed and information collected was revenues and cost information from the farm households farming activities. Budget enterprise was used to get the individual landowners profit. This tool helped to estimate profitability for each land use practice and the NPV was then used to estimate the profitability of a land use over many years. The analysis also employed theoretical models in calculating and obtaining desirable values. The main models used for the calculations are subsequently described in this section.

2.3.3 Financial Model Used:

Below is how to convert nominal interest rate into real interest rate.

The real interest rate = $\frac{i-m}{1+m}$,

Where i (nominal interest rate) = 21% and m (inflation rate) = 16.4%

Therefore, 21% - 16.4%/1+16.4%

= [(0.21-0.164)/1.164]*100

Real interest rate = 4%

To get the real interest rate for one of the rates used, 16.4% inflationary rate was subtracted from the current interest rate of 21%, which was then divided by the 16.4% plus 1 and then multiplied by 100. The same procedure was used to achieve the other real interest rates.

The following formula was used in getting the real dollar for the study. In converting nominal dollars to real, year-a (current year) dollars were divided by CPI for year-and then multiplied by CPI of year-b (expected year). The CPI for 2015 is GH¢141 and GH¢162 is the expected CPI from 2020 to 2050.

Real dollars: $real\text{-}\$_b = \frac{nominal\text{-}\$_a}{CPI_a} * CPI_b$ where CPI is the Consumer Price Index

$= \frac{3.392}{141} * 162$

= GH¢3.8972 (convert to dollars)

Therefore the real dollar used =US$1.15

The study first did the calculations in Ghana cedis and later converted it to US dollars using the then exchange rate of 1US$ to GH¢3.40. It also assumes duration of 30 years since real carbon crediting projects usually have a life time within 10 to 30 years and also the economic lifetime for both cocoa and oil palm ebb from the year 25 through to 40.

2.3.4 NPV Calculation for Food Crops:

In addition to the main crops (cocoa and oil palm), farmers also plant understory crops like cassava and maize as the temporary shade for their main crops. Because these are not their major crops, information as to the cost involved in producing those crops were hard to come by so the calculation for the NPV was based on assumption. Despite the difficulties in acquiring data, the majority of the farmers disclosed in the interview that they earn an average of GH¢330 in sales every season of which there are two seasons in a year. Meanwhile, a study by Damnyag et. al. (2014) in the same district of this study is in consistent with their claim. It posits that an average revenue earned by farmers in Ghana for a hectare of cassava farm is GH¢347 for the first season and GH¢45.59 for the second season. And for maize production, farmers earn average revenue of GH¢502 and GH¢18.99 per hectare in the first and second seasons respectively. Based on the proximity and for the accuracy of results, Damnyag et al.'s (2014) result was adopted for the NPV calculation. Therefore the average annual revenue of farmers in the study for cassava and maize are US$121/ha and US$160.58/ha (in real dollars) respectively.

2.3.5 NPV for Shaded Cocoa and Oil Palm:

Since REDD+ has not yet been implemented in Ghana, acquiring data on planting under shade in the study area was beyond the bounds of possibility. We therefore adapted the work of Nunoo et al. (2014) conducted in Sefwi Wiaso district, one of the largest cocoa producing districts in the country. The annual average yield of farmers in that area under shade and without shade is 546kg/ha and 794kg/ha respectively which produces approximately twice the annual average yields of the three communities under study. The study therefore assumed that if that is the case, then when the communities under study engage in planting under shade probably they might produce half of Nunoo et al.'s work which is 546kg/ha. Hence 273kg/ha is assumed as the annual average yield for the three communities if engaged in shade planting. The study again assumed an annual average yield of 0.6629 t/ha, 0.6629 t/ha and 0.75 t/ha for Odoben, Bedum and Asikuma respectively for the shaded oil palm planting because oil palms production under shade also gives poor yields (Corley and Tinker, 2008). This assumption is based on the one-fourth (1/4) decrease in cocoa yields when planted under shade in the study area.

2.3.6 Carbon Stock Calculation:

The study could not acquire data on the carbon stock of the project site due to financial constraints. It therefore resorted to literature for the calculation of the carbon stock of the proposed projects sites. The study assumed the mean carbon stored by unshaded cocoa and oil palm on per hectare of lands in Asikuma-Odoben-Brakwa district as 76.3 tC/ha and 40.5 tC/ha respectively. This was adapted from a 2014 report of Swiss State Secretariat for Economic Affairs (SECO), Centre for Scientific and Industrial Research (CSIR) and Forestry Commission (FC) of Ghana, the reason being that both studies are in the same region. Also for the shaded cocoa, the study assumed 155.1 Mg C ha^{-1} or 155.1tC/ha (Asaase et. al., 2008) and for the shaded oil palm an assumption based on Montagnini and Nair (2004) assertion that an agroforestry stores 50 tC/ha of carbon in a humid region. The latter was adapted based on the fact that Ghana is also humid and there is not much work on the carbon stock of shaded oil palm.

The total carbon stock change was calculated by following method (Carré et al., 2010)

$\Delta C_{LUC} = (C_{AFTER} - C_{BEFORE}) * A_{TO}$

Where:

ΔC_{LUC} Carbon stock changes as a result of conversion from a generic land-use category to cropland (tC/ha). If Δ CLUC is negative there is a decrease of C-stock in "after" compared to "before" land use, indicating emissions of CO_2 to the atmosphere.

C_{BEFORE} Carbon stock on land before the conversion (tC/ha).

C_{AFTER} Carbon stock on land after conversion (tC/ha).

A_{TO} Area of land use converted to another land use in a given year. A_{TO} = 1 ha.

3.0 Results and Discussion:

3.1 Demographic Characteristics of Farmers:

Among the 75 respondents interviewed from the three communities, 81.9% were males and 18.1% were females. Majority of the farmers interviewed were above the age 45. Asikuma recorded the highest within that age range (73.3%), followed by Bedum (58.3%) and Odoben (56%) all within the same age group. An average of 37.3% of the respondents were between the ages 18-45 with Odoben recording the highest (44%). This implies that a lot of the youth in these three communities are not into farming. The details of the demographic characteristics of the farmers are summarised in Table 3.

Table 1: demographic characteristics of farmers

Item / Community	Odoben	Bedum	Asikuma	Total
Sample size	25.0	12.0	38.0	75.0
Age (%)				
18-45	44.0	41.7	26.3	37.3
Above 45	56.0	58.3	73.7	62.7
Sex (%)				
Male	72.0	100.0	73.7	81.9
Female	28.0	_	26.3	18.1
Household size	6.3	4.5	6.7	5.8
Main occupation	25.0	12.0	38.0	25.0
Alternative sources of income (%)				
Crop production	40.0	50.0	50.0	46.7
Sale of timber	40.0	33.3	34.2	35.8
Others	4.0	8.3	10.5	7.6
None	16.0	8.3	5.3	9.9

Table 2: Educational background of farmers

Item/Community	**Odoben**	**Bedum**	**Asikuma**	**Total**
Educational background (%)				
Educated	76.0	83.3	73.7	77.7
Uneducated	24.0	16.7	26.3	22.3
Level of education (%)				
Primary	16.0	_	10.5	8.8
Middle School	64.0	91.7	68.4	74.7
Secondary school	20.0	8.3	15.8	14.7
Informal	_	_	5.3	1.8

Table 3: Land sizes in acres

Community	Land size in acres			
	Up to 5 acres	**6 – 10 acres**	**11 – 15 acres**	**Above 15 acres**
Odoben (%)	56.0	20.0	8.0	16.0
Bedum (%)	50.0	25.0	_	25.0
Asikuma (%)	47.4	23.7	7.9	15.8

The average household size is 5.8. This varies in the individual communities. Factually, the more rural the community is the larger the household size but it is vice versa in this study. Rather, Asikuma which is the capital of the district has an average household of 6.7 as compared to the 4.5 for Bedum which is more rural[1] than Asikuma. This is because most rural communities in Ghana lack infrastructural facilities like good roads, access to health care, etc. leading to increase in mortality rate in these communities.

Table 1 shows 100% of the respondents are farmers with of course more males (81.9%) than females even though there are other forms of occupation in the district. However, some of the respondents revealed that they have alternative source of money like remittances from their family members outside the district. In addition, most of them aside their farming get money from the sale of timber they cut from their farms. Averagely, 38.8% and 46.7% from the three communities earn money from the sale of timber and crops respectively from their farms.

Regarding education, out of the total sample of 75 from the three communities studied, 77.7% of the farmers had a form of education. Majority of them are middle school leavers with Bedum recording the highest of 91.7%, followed by 68.4% and 64% from Asikuma and Odoben respectively. Some of the farmers had the opportunity to graduate from the secondary school and only a handful of the farmers from the three communities had an informal education in the form of carpentry, masonry, tailoring, etc. as depicted in Table 4.

3.2 Land Acquisition, Land Tenure and Land Use Practices:

Land tenure systems in the study area are inheritance, leasehold and sharecropping. Respondents who acquired their land through inheritance are the majority. About 81% of the interviewed gained possession of their land through either parents or it was given to the family by an ancestor, followed by sharecropping and leasehold recording 12.7% and 6.3% respectively. Nearly 75% of the farmers acquired their lands with virtually no dispute but the remaining farmers encountered problems like high cost of land, competition from family members and land owners which happened long time ago. Few farmers especially the sharecroppers had issues with expiration of tenancy agreement. The problem here is that the tenancy period is usually not long. However, the cost of land was not included in the calculation of profits as some analysts say the opportunity cost of the land already owned or controlled by farmers have already being considered. The World Bank (2011) argument concerning this issue is that it makes little sense to include the cost of land in profitability estimates when comparing two activities, because the cost cancels out.

As estimated by Ministry of Food and Agriculture, a sizeable amount of the farming population in the district has farmlands up to 2 hectares and about 18% have farmlands above 2 hectares. Majority of the farmers from the three communities interviewed have up to 5 acres plot of land approximately 2 hectares whilst 56% of Odoben farmers possess land as low as 0.2 acres up to 5 acres with Asikuma having the least of 47.4%. However, some farmers in these communities owned lands which are above 15 acres with Bedum recording the highest of 25%.

The main type of agriculture practice in the study area is mixed cropping. Farmers plant food crops as a temporary shade for the main crops to resist climate extremes and to suppress plants from diseases, etc. Generally, cocoa and food crop production are the major land use practices in the area. Farmers' use the food crops such as maize, cassava, etc. as their shade because they think planting trees in the cocoa farms leads to lower yields. Also some farmers interviewed said they plant food crops in place of trees for the fear of loggers destroying their farms. Figure 3 shows majority of the farmers in the three communities patronising in cocoa and food crops production instead of planting cocoa only. Apart from cocoa, some of the respondents are also into palm production with Bedum (24%) recording the highest of the farming population engaged in palm and food crops. In total, an average of 14.1% of the farmers in all three communities' plant palm alongside food crops.

[1] Rural here refers to underdeveloped

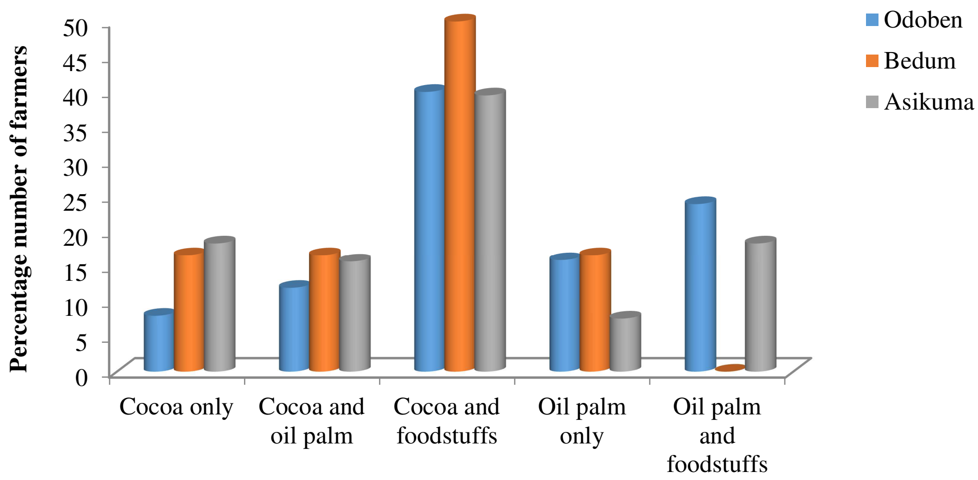

Fig. 3: Various land use practices

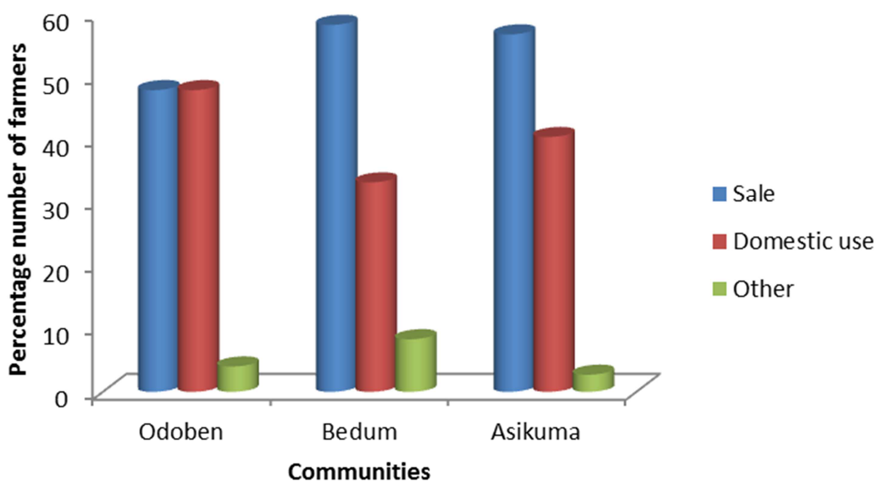

Fig 4: The use of the temporary shade

Further interaction with the respondents brought to the realisation that most of the crops they plant as temporary shades are later sold or used domestically. This is depicted in the figure 4. A comparison across all the communities indicates that nearly 55% of the farmers sell their temporary shade crops, 40.6% use them domestically while about 5% benevolently give them away or in exchange for other goods.

Out of the 54.4% of the farmers who sell their temporary planted shade, 50.2% of them disclosed that they usually earn between GH¢100-500 and only 17.3% earn between GH¢600-1000 for each season. However, 32.5% of them said they earn below GH¢100 (Fieldwork, 2014).

3.3 Analysis of Farmers' Revenue from Existing Farm Practices:

The net income of the various land use was achieved with the help of enterprise budget. In the first and second years, all three communities were rather incurring cost instead of profit due to the high investment of establishing a farm and moreover, because both crops start bearing fruits from the third year. Profits in the first two years are negative as shown in Table 4.

Table 4: Profitability of current land use system in the three communities

Year	Odoben (US$/ha)		Bedum (US$/ha)		Asikuma (US$/ha)	
	Cocoa	**Palm**	**Cocoa**	**Palm**	**Cocoa**	**Palm**
1	-232	-156	-241	-162	-218	-148
2	-34	-42	-45	-42	-44	-49
3	266	221	245	221	254	248
4	251	191	217	191	231	211
5 up to 30	167	106	128	106	143	113

This is as a result of the one-time establishment cost which is incurred at the beginning of planting and harvest starting from the third year hence negative benefits.

Cocoa and oil palm planting are both labour intensive. All three communities are involved in similar stages of production which are land preparation, weeding, nursery establishment, planting, fertilisation, pruning and harvesting. Right from land preparation through to harvesting requires human tendering. This undoubtedly affects the cost of establishing and maintaining a farm in these areas. The cost of production differs in all the three communities. This is due to the varying number of people (labour) used at each level of production. Asikuma for instance incurs the highest cost of US$326.63/ha in production/maintenance in oil palm production. This maximal cost owes to the fact that more hands are employed in Asikuma to assist in the harvesting and the processing of oil palm than the rest of the two communities.

Moreover, fertilizer, pesticides and herbicides application boost yield. Regardless of these facts, application of fertilizer, pesticides and herbicides were not common with most households for all villages; some use fertilizers and others do not depending on their financial status. Prices for fertilizers depended on the type of fertilizer but the study chose the price of the most commonly used in these three communities for the profitability calculations. With a daily wage of $4.05, figures from Table 4 reveal Bedum recording the least benefit of US$241 in the first year of production. This is as a result of huge sums of money they pay to labourers (US$105.3) for the preparation, planting and nursery establishment as compared to Odoben which only incurs US$93.15 and also as a result of quiet a percentage of their farmers falling in the category of old age as compared to Odoben.Another essential factor leading to the variations in profits from the early stages of production are due to the 15%, 25%, and 70% annual maintenance estimate employed by the study. These assumptions were made based on the respondents' revelation that into their second through to their fourth year of production, they do not spend much on maintenance.

Nonetheless, farmers start making profits from the third year but profits differ with each land use system. With the communities understudy, there are variations in the profits of both land use systems but cocoa is the topmost in all the three communities. Figure 5 is an undiscounted multi-year analysis for Odoben showing how profit levels transforms annually with time horizon and also the vast variations in profit for the two crops. Profits in the study areas differ from the first years till the fifth year and then stabilises for the rest of the period.

Farmers profit in the three communities for the two crops ranges from US$106/ha to US$266/ha. Cocoa records the highest income of US$266/ha in Odoben and the least profit is US$106/ha for oil palm recorded by both Odoben and Bedum. Contrary to figure 5, figure 6 depicts how profits undulate with time. This is due to the inconsistency of the discount rate in Ghana which could shun investors from taking interest in projects with long term lifespan. Profits increases with a decrease in the discount rate. Profits for both land use practices started descending from the fifth year when the interest rate increased from 3.2% to 3.9% but slightly went up at year sixteen when interest rate decreased to 2.9%. The real discount rate used is 4%, 3.2%, 3.9% and 2.9%

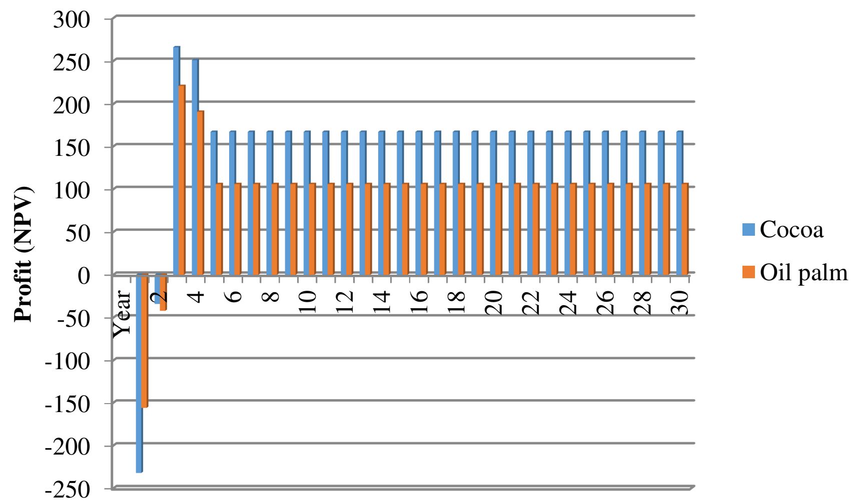

Fig. 5: An undiscounted multi-year analysis for Odoben

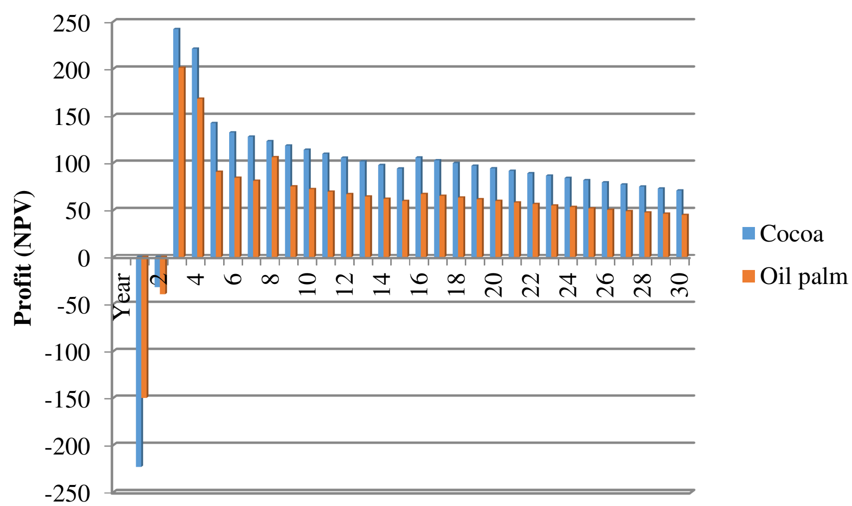

Fig. 6: A discounted multi-year analysis for Odoben

Table 5: NPV for the three communities

Crops	NPV (US$/ha)		
	Odoben	Bedum	Asikuma
Un-shaded Cocoa	2,783	2,114	2,389
Un-shaded Oil palm	1,842	1,809	1,966
Shaded cocoa	492	213	300
Shaded oil palm	169	161	98

3.4 Net Present Value of the Various Land Use:
Results of the NPV analysis are in Table 5. NPV estimates for the 30-year time frame with real discount rates of 4%, 3.2%, 3.9% and 2.9% ranges from US$1,809 per hectare to US$2,783 per hectare. With the NPV for palm oil recording the least in the Odoben community followed by Bedum's oil palm which recorded US$1,842 and US$1,809 respectively, whereas Odoben recorded the highest of US$2,783.

Comparatively, planting under shade records low NPV, the highest NPV under this practice was recorded by Odoben (US$492) and the least by Asikuma (US$98). This shows that planting under shade is typically characterized by low yields. Considering the adoption of the real interest rate for the NPV calculation, values change with time (as depicted in Figure 7) unlike the undiscounted analysis where values stabilize after the fifth year.

Additionally, the NPV for cassava and maize for all the three communities are US$2,312/ha and US$3,069/ha respectively. These positive NPV's were also calculated for a 30-year time frame with real discount rates of 4%, 3.2%, 3.9% and 2.9%. Table 6 shows the calculation of the NPV for maize and cassava which was based on a study conducted by Damnyag et al. (2014) in the same district of this study.

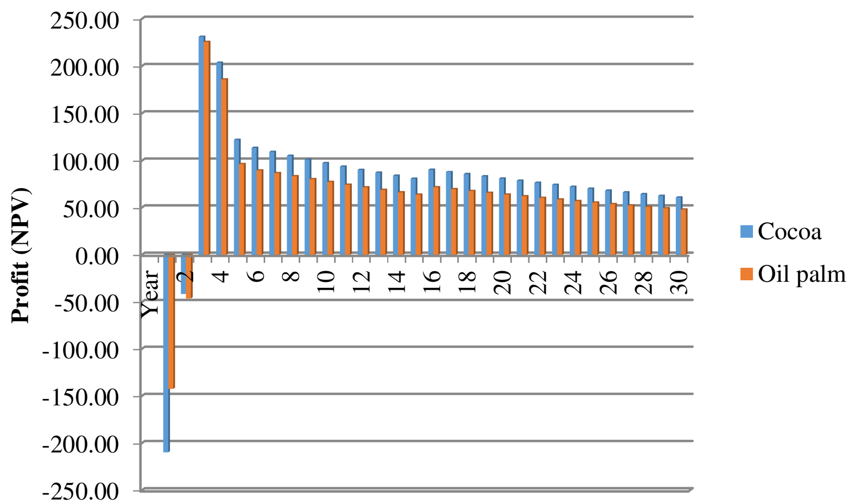

Fig. 7: A discounted multi-year analysis for Asikuma

Table 6. Calculation of the NPV for maize and cassava in the three communities

Items/ year	NPV	1	2	3	4	5	6	7	8	9	10	30
Cassava	**2312**	116	114	110	107	103	96	93	89	86	83	51
Maize	**3069**	154	151	146	142	137	128	123	118	114	110	68
	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha

3.5 Linking Opportunity Costs with Carbon Stock Changes

For the analysis of opportunity costs the carbon content for each land use practice is needed. Estimation of opportunity cost is characterised by both carbon stock and NPV. Both characteristics are linked as depicted in Figures 7, 8 and 9 to achieve opportunity cost. The carbon stock of shaded cocoa is 155.1 tC/ha which is equivalent to 569 tCO_2/ha and the carbon stock of unshaded cocoa farm is 76.3 tC/ha or 280 tCO_2e/ha. Shaded oil palm is 50t C/ha or 183.5 tCO_2/ha and un-shaded oil palm is 40.5 tC/ha equals to 148.6 tCO_2/ha. Tonnes of carbon per hectare (tC/ha) was converted to tonnes of carbon dioxide equivalent per hectare (tCO_2/ha) by multiplying tC/ha by 44/12 or 3.67 (Pearson, et. al., 2007).

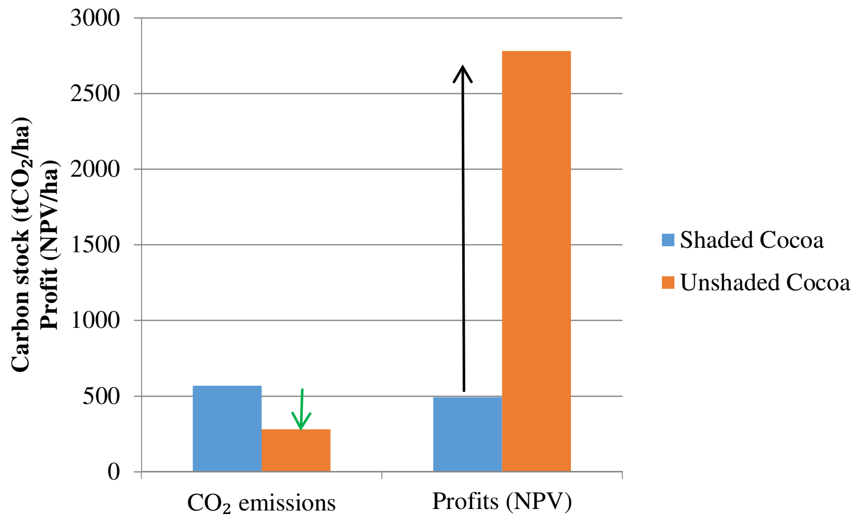

Fig. 8: Correlation of NPV and carbon stock of cocoa in Odoben.

The short arrow in the above figure indicate a lost in CO_2 emissions if farmers engage in full sun planting instead of shade planting and the long arrow indicate the profit gained if farmers engage in full sun planting instead of shade planting. Thus if farmers in Odoben change their current land use practice to shade cocoa planting, they will conserve 289 tCO_2/ha at an opportunity cost of US$2,291 (with reference to Table 7). Therefore, the opportunity cost per tCO_2 as a result of planting cocoa under shade will amount to 9.63 $/$tCO_2$. Likewise the opportunity cost for Bedum and Asikuma, if farmers decide to change their current land use practice to planting cocoa under shade they will forgo an NPV of US$1,908 and US$2,089 respectively. Their opportunity cost per tCO_2 due to planting cocoa under shade will also be 6.6 $/$tCO_2$ (Bedum) and 7.2 $/$tCO_2$ (Asikuma). Figure 9 shows benefits Asikuma farmers gain in their current land use practice and how much emissions are at stake.

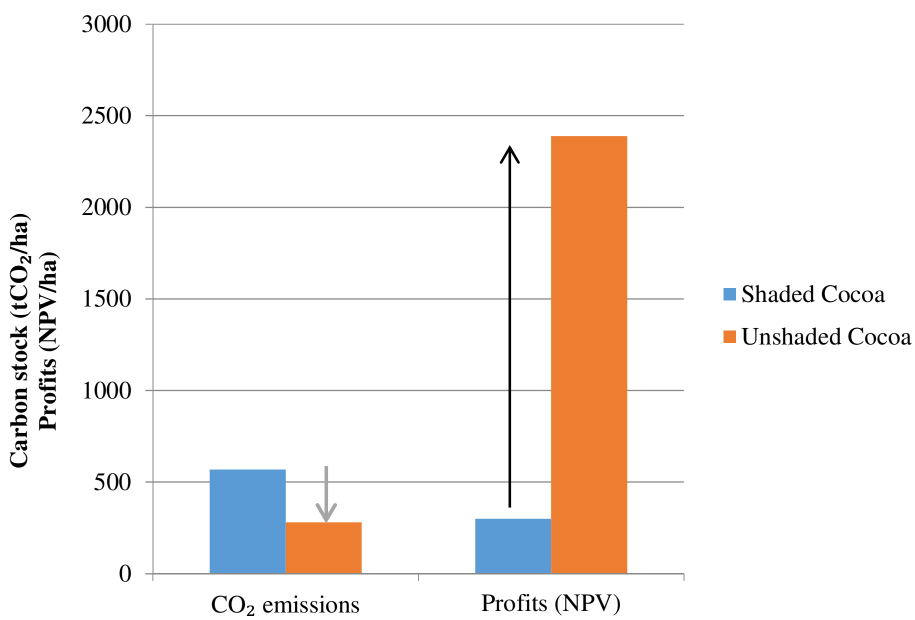

Fig. 9: Correlation of NPV and Carbon Stock of cocoa in Asikuma

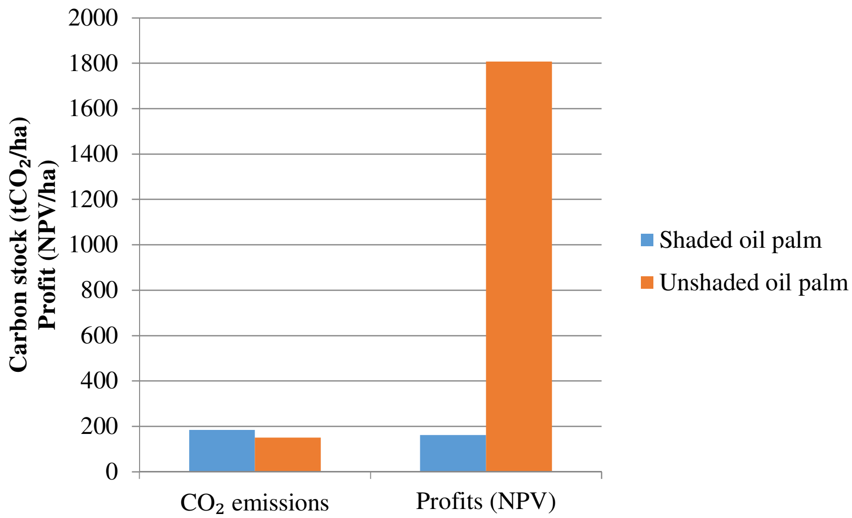

Fig. 10. Correlation of NPV and carbon stock oil palm in Bedum

Furthermore, farmers in these three communities who are into full sun planting of oil palm will incur an opportunity cost of US$1,673, US$1,648 and US$1,868 for Odoben, Bedum and Asikuma respectively if they convert to planting under shade. All communities will only conserve 34.9 tCO_2/ha if they plant under shade. Their opportunity cost per tCO_2 will range from 47.2 \$/tCOe to 53.5 \$/tCO_2. The arrow in figure 10 shows the profits gained by Bedum farmers if they continue with their current practices. The difference in emissions if they change their land use practices in this case is very small. They will only emit 34.9 tCO_2/ha if they continue with their old practices. The total carbon stock change in the two land use practices is therefore negative indicating emissions of CO_2 into the atmosphere. The carbon stock change for cocoa using Carré et al., (2010) method is -289 tCO_2/ha and -34.9 tCO_2/ha for oil palm. This result is an indication that maintaining the traditional land use practice would be of great danger to the climate due to its greater share of emissions into the atmosphere.

The above results show that the development of cocoa and oil palm are eminently profitable. The undiscounted net income for the cocoa and oil palm ranges from US$106 to US$266 per hectare. These results when discounted resulted in positive NPV for all crops for the 30 year horizon. Using real discount rates of 4%, 3.2%, 3.9% and 2.9%, the net benefit per hectare of land will generate an NPV ranging from US$1,809 to US$2,783 for cocoa and oil palm. In addition to these main crops, profit from harvested food crops used as temporary shade also has an undiscounted net income of US$121/ha and US$160.58/ha for cassava and maize later augmenting to US$2,312/ha and US$3,069/ha after discounting with the same real discount rate respectively. According to literature (see e.g. Boardman et al., 2011) a project is said to be profitable if the present value is greater than zero and correspondingly all the NPV in the results are greater than zero.

Moreover, observations made concerning the profitability of this study show varying trends of profits for the various land use type. Higher labour cost and differences in yields are among the factors that brought about the variations. Except for seedling and labour costs, all other costs are minimal. Seedling cost, which is usually incurred in advance, is a one-time cost but a very important cost. The rationale for high labour cost is that both land use practices are labour-intensive from land preparation till harvesting and as a result more hands are employed to carry out farming activities and this engenders labour cost subsequently increasing the establishment and production costs which collaborates the study by Damnyag et al. (2014). Establishment and production costs differed in all three communities. This was due to the varying number of people (labour) employed for various activities. Basically, households in the study area use family members and exchange labour for all farming activities which is virtually free, hence more profit for these farmers. Large households benefits are more inasmuch as they engage family members in farming activities by-and-by saving monies meant for labour and subsequently accumulating profit. Labour wage in the study areas in effect are implicit but for the benefit of knowing the actual cost for REDD+, labour cost was calculated based on those few farmers who resort to labourers as did by Adu-Bredu et al. (2008).

Even though, the absence of shade places significant ecological stress on cocoa trees, which become susceptible to pests attack (Entwistle and Yeodeowei, 1964: cf. Ofori-Frimpong et al., 2006), yet still the above findings established that unshaded cocoa production is highly profitable at between US$2,114 /ha to US$2,783/ha than shaded cocoa planting. A big gap exists between the two farm practices. This might be because of the higher litter decomposition under unshaded farms since litter fall is very high under unshaded cocoa farms (Ofori-Frimpong et al., 2006) probably leading to greater yields. A survey conducted in the Western Region of Ghana, one of the major cocoa producing regions in 2001/2002 by Gockowski and Sonwa, (2008) showed that there are more cocoa systems with no shade and less cocoa systems with medium to heavy shade compared with the national average. Cunningham and Arnold (1962) reported that the removal of shade from cocoa planting results in significant increases in yield with a positive interaction between increased light and applied nutrient. This therefore attests to the reason why cocoa under full sun in the study area has higher NPV. But unfortunately not all studies concur to this result. Matieu's (2010) report opposes to this study, the study revealed a $506/ha/year for shaded cocoa opposing to $269 profit for unshaded cocoa implying that shaded systems have a significantly larger economic potential than unshaded systems. Nonetheless, yields in these communities are very poor as compared to other districts in Ghana. This is due to climatic conditions and lack of funds to buy chemicals and improved hybrid seeds in order to increase production. Although yields in the districts are very low compared to other cocoa and oil palm producing districts in the country, inputs are very low rendering higher profits.

All in all, the current land use practices are unquestionably profitable to farmers in all the three communities under study. The NPV is higher than that of shade planting implying higher profits for unshaded farming. Profits are mostly accepted as an indicator of success of an economic activity (Offermann and Nieberg, 2000: cf. Nemes, 2009) implying that farmers in Odoben-Asikuma-Brakwa district are thriving in their current land use practice considering their low standard of living. Hence the probability of farmers not engaging in REDD+ is very high because of the higher NPV. Changes in land use affect the vegetation and soil of an ecosystem and hence it changes the amount of carbon held on a hectare of land (Houghton and Goodale, 2004). It can either capture or release CO_2 into the atmosphere. Findings from this study revealed that a change from unshaded cocoa or oil palm planting to shaded planting captures CO_2 increasing carbon stock and vice versa which supports findings by Ofosu-Budu and Sarpong, 2013). Analysis shows that cocoa and oil palm production under traditional system (unshaded) emits 289 and 34.9 per tons of CO_2 per hectare of land respectively. However, a change from this traditional cocoa and oil palm systems to planting under shade will avoid the emissions of 289 tCO_2/ha and 34.9 tCO_2/ha respectively into the atmosphere. This result is a bit similar to that of Matieu (2010) study which reported a 65 Mg C ha^{-1} or t C/ha 238.55 to be sequestered if land is converted from unshaded to shaded systems.

The most surprising finding in this study is the carbon stock of oil palm production. The change in carbon stock between unshaded planting and shaded planting appears to be very small. Results show that the current land use practice for unshaded oil palm only emits 34.9tCO_2/ha as compared to the 289tCO_2/ha for unshaded cocoa. The big difference may be as a result of the clearing and burning system of planting cocoa because according to Dawoe (2009), the greatest loss of carbon usually occurs at the land preparation stage prior to first cultivation which loses an average of 65% of total carbon stocks. However, with the NPV for the various land use practice, conversion from unshaded to shaded planting will mean higher opportunity costs. Thus, if farmers in Asikuma whose NPV is US$2,389/ha for 30 years decide to change from planting under full sun to planting under shade, they will incur an opportunity cost of US$2,089/ha. Likewise Odoben and Bedum with NPV's of US$2,783/ha and US$2,114/ha will generate an opportunity cost of US$2,291/ha and US$1,908/ha respectively for cocoa and US$1,673/ha and US$1,648/ha for oil palm. Moreover, the opportunity cost per ton for Odoben, Bedum and Asikuma if they change unshaded to shaded cocoa planting will amount to 9.63$/$CO_2$, 6.6$/CO_2 and 7.2$/$CO_2$ respectively. Thus the average opportunity cost per ton for the district will be 7.81$/$CO_2$ in case they decide to conserve more carbon. This compared to Olsen and Bishop's (2009) opportunity cost of

US$4.29/$tCO_2$ for a carbon content of 277 ton C/ha from a peat land to forest is moderately high but similar to UN-REDD's (2012) opportunity cost of US$ 7.3 tCO_2 for the avoidance from the conversion of natural forest to pastoral land. This amount is moderate for implementers of REDD+ since it falls within the US$2.76 to US$8.28, price range of carbon estimated in the Stern Review (2007) on climate change. On the contrary, the opportunity costs per ton for oil palm in this study for all the three communities are exorbitantly high ranging from US$47.9, to US$53.5. This could be as a result of fewer infrastructures for the processing of oil, higher inputs and lack of technology leading to higher opportunity cost per tCO_2 which can cause REDD+ to be futile.

From the analysis, it could be adjudged that the traditional system is economically viable than planting under shade. In order to attract farmers to engage in activities that will decrease CO_2 emissions, they should be amply compensated. Even though the benefit sharing arrangement for REDD+ in Ghana is still under development (Fieldwork, 2014), findings from the study indicate that compensation must not be less than the opportunity cost of the farmers obtained in this study. In the case of Asikuma, farmers will willingly participate in any climate change mitigation program if they are compensated for not less than 7.2 \$/tCO_2 or U$2,089 per hectare. Nevertheless, it is unquestionably true for all the other two communities engaged in full sun planting. Thus to ensure that they fully participate in any climate mitigation program, they should be compensated for not less than their opportunity cost per ton or CO_2. In a nutshell, the average opportunity cost per tCO_2 to be given to farmers in the Odoben-Asikuma-Brakwa district to ensure full participation in REDD+ activities if introduced and further ensure permanency must not be less than 7.81 \$/tCO_2 for cocoa farmers and an average of not less than 49.5\$/tCO_2 for oil palm farmers. Comparatively to other countries, the opportunity cost per ton of carbon dioxide in the study area is very high. Factors like poor climatic conditions, lack of technology and hybrid seeds, lack of finance to purchase fertilizer, etc. could be the cause of higher opportunity cost per ton in the study area.

Employing oil palm as an activity for REDD+ in Ghana will not be a valuable idea for its feasibility. The analysis revealed that, oil palm has an average opportunity cost per ton of carbon to be 49.5\$/t CO_2. This might practically engender the cost of REDD+ making future implementation unfeasible. Thus if REDD+ uses oil palm production as one of their activities, huge sums of money must be given to participants as compensation hence engendering implementation cost. A study conducted by Swallow et al., (2007) in three Indonesian provinces discovered that between 6 – 20% of emissions from agriculture, forestry and other land uses generated financial returns less than \$1 per ton of CO_2e and between 64 and 90% of the emissions provided financial gain less than \$5 per ton of CO_2e. This clearly brings to bear the favourable circumstances presenting REDD+ to be a feasible solution for climate change mitigation. Contrary to this assertion is the result of this study pertaining to the highest opportunity cost per ton of CO_2 for oil palm Odoben-Asikuma-Brakwa district which will in the long run sabotage the feasibility of REDD+ as a climate change mitigation measure. Despite the highest opportunity cost per ton of CO_2, oil palm captures the least carbon compared to the carbon stock of cocoa making full sun cocoa planting to qualify for REDD+. The study also shows socioeconomic issues such as gender, age and education have serious implication on REDD+ implementation in the district in as much as these issues could enhance productivity hence engaging in REDD+ activities. However, Land tenure system does not much affect REDD+ implementation in the district since majority of the farmers acquired their land through inheritance. The only problem that could underscore REDD+ participation will be the sharecroppers and leaseholders who are more often in conflict with the terms of their tenancy agreement that governs their farm (see e.g. Peskett, 2011). This would obviously dissuade farmers from participating in any land improving or climate improving investments and also making lenders to shun away from financing investments that might improve farms in the study area or any climate mitigation measures in the area.

4.0 Conclusions:

This study has attempted to provide a comprehensive analysis on factors that can facilitate the sustainability of REDD+ if implemented in Ghana and in the process has identified factors that can boost permanency. The paramount factors identified includes the right amount per ton of carbon to be paid, the perfect land use practice that is highly profitable with a high carbon capturing capacity and other socio-economic factors that are necessary to ensure sustainability if adhered to. The result of the study indicates that planting without shade is an attractive option to farmers than planting under shade. Thus planting without shade was highly associated with higher profits than planting under full sun. This implies that the current land use practice provides a more attractive option than REDD+ so in order to realise REDD+ objectives, farmers in Ghana have to be immensely motivated to ensure full participation. Also, the study shows that the carbon capturing capacity for cocoa and oil palm is high with an increase in shade but low in yields. On the other hand, emissions are very high with a decrease in shade but high in yields. For that matter, prudent measures like REDD+ must be imposed to prevent the emissions of more carbon. All in all, based on the results of this research, it is convincing that REDD+ can be successfully implemented in Ghana if opportunity costs of participants are met by the implementers. Considering the importance of the scheme, it is recommended that the government of Ghana takes ownership of the REDD+ scheme as a pathway to sustainably manage its forest resources and not depend wholly on support from the international bodies.

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