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Above Ground Biomass and Carbon Stock in Some Perennial Crop Based Agroforestry Systems in the Humid Forest Zone of Cameroon

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors designed the study, wrote the protocol and author NJN wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: To estimate the above ground biomass and carbon stocks of Cocoa, Oil palm and Rubber based agroforestry systems in the humid forest region of Cameroon.
Place and Duration: A field survey was carried out on 39 typical perennial crop-based agroforestry farms, distributed around Kumba and extending to the Bombe-Malende zones (4°25'- 4°80' N and 9°25'- 9°35' E) in the South West Region of Cameroon in 2009.
Methodology: The main criteria for the selection of farms was that they constituted the major perennial crops (Cocoa, Oil palm or Rubber) associated with each other or with other perennial crops as well as food crops. Thirty-nine perennial crop-based agroforestry farms were selected and the number of each tree species was counted and recorded, the diameter at breast height (DBH) and approximate heights taken. Diameter measures of trees and palms were individually converted to measures of above ground biomass (AGB) based on allometric equations and carbon content

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was estimated as 50% of the biomass.
Results: The studied farms were highly diversified with different species, which were used for food, timber or provided products that were sold. The carbon stock per unit farm varied greatly; Oil palm-based agroforestry system presented the highest above ground carbon; an average of 72.5 Mg C/ha followed by Rubber-based agroforestry system (36.3 Mg C/ha) and lastly by Cocoa-based agroforestry system (6.23 Mg C/ha).
Conclusion: The studied systems stored a substantial amount of carbon besides meeting the immediate needs of the farmers such as food and income generation. The allometric equations for the estimation of biomass need to be developed for this region in order to get more reliable results.

Keywords: Agroforestry; biomass; cocoa; oil palm; rubber.

1. INTRODUCTION

Carbon dioxide (CO_2) is a dominant greenhouse gas. The concentration of CO_2 and other greenhouse gases (GHGs) in the atmosphere has considerably increased over the last century and is set to rise further. Carbon dioxide is accumulating in the atmosphere at a rate of 3.5 Pg (Pg = 10^{15} g or billion tons) per annum, the largest proportion of which resulting from the burning of fossil fuels and the conversion of tropical forests to agricultural production [1]. The direct solution to the problem is reducing CO_2 emission. The ability of the terrestrial biosphere to sequester and store atmospheric CO_2 has been recognized as an effective and low-cost method of offsetting carbon emissions. Carbon sequestration potential differs with the kind of land use. According to the International Panel on Climate Change (IPCC) report of 2000 [2], agroforestry has been recognized as having the greatest potential for C sequestration of all the land uses. However, considering the huge human population and degraded areas in developing countries, the immediate need is to provide food and under such circumstances, much of the land cannot be spared for increase in forest cover. Agroforestry becomes therefore very important for climate change and food security especially in Africa [3].

Trees act as a sink for CO_2 by fixing carbon during photosynthesis and storing excess carbon as biomass [4]. Tree-based land-use systems – natural forest, forest plantations and agroforestry systems – sequester CO_2 through the carbon (C) stored in their biomass. By promoting land-use systems which have higher C contents than the existing plant community, net gains in C stocks (hence sequestration) can be realized. The most significant increases in C storage can be achieved by moving from lower-biomass land-use systems (e.g. grasslands, agricultural fallows and permanent shrub lands) to tree-based systems [5].

Carbon sequestration through forestry is based on two premises. Firstly, that carbon dioxide is an atmospheric gas that circulates globally; consequently, efforts to remove greenhouse gases (GHG's) from the atmosphere will be equally effective whether they are based next door to the source or across the globe. Secondly, green plants take carbon dioxide gas out of the atmosphere in the process of photosynthesis and use it to make sugars and other organic compounds used for growth and metabolism. Long-lived woody plants store carbon in their wood and other tissues until they die and decompose at which time the carbon in their wood may be released to the atmosphere as carbon dioxide, carbon monoxide or methane, or it may be incorporated into the soil as organic matter [6].

Perennial systems like homegardens and agroforests can store and conserve considerable amounts of C in living biomass and also in wood products [4]. However, despite the large area devoted to agriculture worldwide, and despite the apparent potential for agroforestry to sequester carbon, the recent proliferation of agroforestry studies includes almost no consideration of either carbon or biomass. The lack of biomass data, coupled with the diversity of agroforestry types (i.e. the wide variation in functional types, species, tree densities, temporal and spatial arrangement of components, management practices, etc.), means that a straightforward estimation of potential carbon storage is not possible [7]. Plant tissues vary in their carbon content. Stems and fruits have more carbon per gram than do leaves, but because plants generally have some carbon-rich tissues and some carbon-poor tissues, an average concentration of 45-50% carbon is generally accepted [8].

In as much as agroforestry play a significant role in mitigating the atmospheric accumulation of greenhouse gases (GHG), it also has a role to play in enhancing the sustainability of agriculture and increasing resilience to climate change [9]. Live tree biomass estimates are essential for carbon accounting, bioenergy feasibility studies, and other analyses. Several models are currently used for estimating tree biomass. Each of these incorporates different calculation methods that may significantly impact the estimates of total aboveground tree biomass, merchantable biomass, and carbon pools [10].

The main objective of this study was to estimate the above ground biomass and carbon stocks of some perennial crop based agroforestry systems in the humid forest region of Cameroon, which could serve as a base for agroforestry system planning.

2. METHODOLOGY

2.1 The Study Area

A field survey was carried out on 39 typical perennial crop-based agroforestry farms, distributed around Kumba and extending to the Bombe-Malende zones (4° 25'- 4° 80' N and 9° 25'- 9° 35'E) in the South West Region of Cameroon. This region falls within the rainforest area (mean annual rainfall of 2,852 mm/yr), with a marked rainy season (March to October), and high mean annual temperatures (~23℃) evenly distributed throughout the year [11]. Soils are ferralitic with patches of fertile volcanic areas, and altitudes varying from 25 to 400 m toward the North. The agroforestry exploitations existing in the area are typically characterized as home gardens [12], that is, intimate multistory combinations of large number of various trees (Oil palm, Rubber trees and Cocoa) and crops (Yams, Cassava, Maize, Banana, Plantain, Cocoyam, etc.), in homesteads as well as fruit trees, timber species, ornamentals and medicinal plants. The main crops and associated perennials of the studied farms are presented in Table 1.

2.2 Selection of Farms

The main problem with farms is that they are usually very small with most farms being less than a hectare. More to this, crops of similar species are of different ages [13]. This makes it difficult to carve out a sample plot that is representative of the actual situation. Farms were thus selected based on the fact that they constituted the main perennial crops (Cocoa, Oil palm or Rubber) associated with each other or with other perennial crops as well as food crops (not considered for biomass calculation). Thirty-nine farms with the desired characteristics were selected and an inventory of the trees and crops planted taken by the survey team with the assistance of farm owners. The farms were grouped on the basis of the major perennial crop.

2.3 Field Characterisation

The plants studied in the home gardens included cash crops, food crops, timber, medicinal and ornamental plants. For each farm the number of each tree species in the experimental area were counted and recorded, the diameter at breast height (DBH) and approximate heights taken. The heights were estimated by measuring the height from ground to breast height with a meter tape and then estimating the rest of the height by observing the height and comparing to the measured height then adding to the measured height. The experimental unit of 500 m^2 was chosen to have a uniform size for the studied farms since most farms were less than a hectare (farm sizes ranged from 0.06 – 4 ha). Trees counted from the 500 m^2 area were approximated to 1 ha. For species that were more than twenty in number, five trees were selected as representative samples and the mean DBH and height measured using a meter tape. For trees with irregularities the DBH was measured at an estimated height of 1.5 m from the ground. The five trees selected for each farm constituted trees with the highest DBH.

2.4 Estimating Biomass and Carbon Stocks

Diameter measures of trees and palms were individually converted to estimates of above ground biomass (AGB), and then summed by plot. Results were then scaled from ton per plot to ton per hectare depending on the size of the individual farm. Models recommended for estimating total aboveground biomass are based on diameter at breast height, the simplicity of these models is advantageous. This variable is easy to measure accurately in the field and is the most common variable recorded in forest inventories [14]. The various models for AGB estimation are presented on Table 2.

Table 1. Characteristics of the studied farms

Farm number	Location	Major perennial crop	Age of major perennial crop*	Farm size (ha)	Tree density (number of trees/500 m^2)	Associated crops
1	Small Ekombe	Cocoa	1	1.5	65	Oil palm, Palms spp., Plantain, Maize, Ground nuts, Morelle, Eggplant, Macabo/Taro
2	Ebonji	Cocoa	1	2	60	Plums, Umbrella stick, Plantain, Pineapple
3	Etam1	Cocoa	1	2	58	Bush Mango, Monkey no climb, Plantain Macabo/Taro
4	Ebonji	Cocoa	2	2	60	Oil palm, Pear, Bush coffee, Cotton tree, Monkey no climb, Boma, Palm spp, Plantain, Macabo/Taro
5	small Ekombe	Cocoa	2	2	63	Plums, Oil palm, Umbrella stick, Plantain
6	Etam1	Cocoa	2	0.75	80	Plums, Oil palm, Umbrella stick, Plantain, Macabo/Taro, Manioc
7	Etam1	Cocoa	3	1.5	63	Oil palm, Njangsang, Small leaf, Palm spp. Plantain
8	Etam 2	Cocoa	3	1.5	61	Small leaf, Macabo, Pineapple
9	Ebonji	Cocoa	3	1.5	61	Small leaf, Macabo, Pineapple
10	Ebonji	Cocoa	4	1.5	65	Oil palm, Plums, Cola nut, Umbrella stick, Macabo, Plantain
11	Mukondje (Dschang quarter	Cocoa	1.5	2	111	Oil palm, Pear, Umbrella stick, Macabo, Plantain
12	Etam2	Oil palm	1	1	8	Cocoa, White wood, Maize, Plantain
13	Mabonji	Oil palm	1	1	15	Cocoa, Umbrella stick, White wood, Cassava, Macabo/Taro, Potatos, Maize, Okoro, corète potagère
14	Mabonji	Oil palm	2	1	12	Umbrella stick, Cassava, Macabo/Taro
15	Mukondje (Dschang quarter	Oil palm	2	0.5	8	Cocoa, Orange, Plantain, Macabo/Taro
16	Ebonji	Oil palm	3	0.35	7	Cocoa, Rubber, Camwood, Iroko, Plantain, Macabo/Taro, Maize
17	Mukondje (Essock)	Oil palm	3	2	8	Plantain
18	Mukondje (Dschang quarter)	Oil palm	4	0.8	12	Cocoa, Small leaf, Macabo/Taro, Maize, Cassava
19	Mukondje (Dschang	Rubber	2	3.5	19	Coffee, Oil palm, Plantain

	quarter)					
20	Etam2	Rubber	4	4	37	Cocoa, Oil palm, Palm spp., Plums. Macabo/Taro
21	Bombé	Cocoa	1	0.374	108	Moganaga spp., Iroko, Plantain, Yam, Cassava, Maize
22	Malendé	Cocoa	1	0.4393	84	Moganaga, Plantain, Macabo/Taro, Cassava
23	Bombé	Cocoa	2	0.3318	55	Kola nut, Moganga spp., Umbrella stick, Palm spp. Plantain Cassava, Yam, Pineapple
24	Malendé	Cocoa	2	0.0678	180	Pear, Plum, kola nuts, Orange, Monganga spp. Palm spp., Plantain, Macabo/Taro, Cassava
25	Bombé	Cocoa	3	0.2398	44	Pear, Kola nut, Mango, Palm spp. Camwood, Iroko, whitewood, Small leaf, Plantain, Macabo, Cassava, Banana
26	Malendé	Cocoa	4	0.5916	18	Plum, Pear, Orange, Umbrella stick, Boma, Plantain, Okoro
27	Bombé	Cocoa	4	1.101	49	Plum, Pear, Orange, Lemon, Orange, Umbrella stick, Christmas bush, Raphia palm, Iroko, Camwood, Plantain, Taro
28	Malendé	Oil palm	1	0.3252	12	Mango, Palm spp. Boma, Cassava, Macabo/Taro
29	Malendé	Oil palm	1	1.3091	10	Monganaga spp., Boma, Plantain, Macabo, Yams, Maize.
30	Bombé	Oil palm	2	0.2101	10	Cocoa, Pear, Umbrella stick, Iroko, Plantain, Macabo,Cassava, Yams
31	Bombé	Oil palm	2	2.3607	12	Cassava
32	Bombé	Oil palm	3	1.1904	12	Cocoa, Small leaf, Plantain, Banana
33	Bombé	Oil palm	3	0.4478	13	Cocoa, Bush coffee, Plantain
34	Bombé	Rubber	1	0.2208	45	Bush coffee, Umbrella stick, Cassava, Yam, macabo
35	Bombé	Rubber	1	0.3903	57	Umbrella stick, Cassava, Yam, Macabo. Maize
36	Bombé	Rubber	2	0.6358	42	Cocoa, Umbrella stick, Plantain, Cassava
37	Dschang quarter	Rubber	2	3.35	19	Cocoa, Coffee, Oil palm, Pawpaw, Plantain, Yam
38	Bombé	Rubber	3	0.85	57	Bush coffee, Palm spp., Cassava, Taro, Plantain, Pineapple
39	Bombé	Rubber	3	0.1	29	Palm spp., Pineapple

*** Age 1 - 2 = immature, not being harvested ** Age 3 - 4 = Mature, being harvested*

Table 2. Models for the estimation of above ground biomass

Above ground component	Model	Source
Cocoa: Leaves	$Y= 0.019^b + 0.349 \times BA$	(Beer et al. 1990) [15]
Woody material	$Y = 0.0376^b + 0.133 X BA$	
Hevea brasiliensis	$W = 0.020G^{2.492}$	(Dey et al. 1996) [17]
Other tree species	Y** = exp(-2.134 + 2.530ln(DBH)	Brown 1997 [18]
Oil Palm	W* = 725 + 197H	(Khalid et al. 1999) [20]

Y = total biomass per tree from all pruned branches, BA = total basal area per tree of all pruned branches and b is intercept value statistically not different from zero, W = Above ground biomass per tree, G = girth in cm, W= Fresh weight in kg and H = height in m, Y** = dry above ground biomass*

Cocoa diameter was first converted to basal area (BA = $\Pi DBH^2/4$) where DBH is diameter at breast height and Π is a constant = 3.142 and then to AGB using allometric models [15]. The model is based on Cocoa trees in laurel (*Cordial alliodora*) or poro (*Erythrina poeppigiana*) agroforestry system. Cocoa stem biomass was calculated by the following equation; Stem biomass = $0.313 \times (DBH^2 \times H)^{0.9773}$ [16]. The leaf, stem and branch biomasses were summed to give AGB for cocoa trees. The AGB of *Hevea brasiliensis* trees was estimated using a regression equation [17], which related the tree girth to biomass. Since no species-specific biomass equation was available in the literature, we used a generalized tree biomass equation [18] for the estimation of the AGB of the other trees species. This equation is considered suitable for estimating aboveground tree biomass of individuals with <150 cm DBH [19], and is recommended for aboveground biomass estimation where destructive sampling cannot be conducted, as in our case due to farmer set restrictions.

Oil palms and Palm species were not grouped with trees for AGB estimates because in contrast to tree AGB, palm AGB is argued to be more reliably predicted by height than DBH, as palms increase biomass through apical growth with little growth in diameter [18]. The AGB of palms and palm species was estimated by using the equation relating the fresh weight of Oil Palm to the height [20]. W = 725 + 197H where H, is height in meters and W is the fresh weight in kg.

2.5 Carbon Content in above Ground Biomass

The annual crops (including Banana and Plantain) were not used for biomass calculations. In reality, C storage in plant biomass is only feasible in the perennial agroforestry systems (perennial-crop combinations, agroforests, windbreaks), which allow full tree growth and where the woody component represents an important part of the total biomass [1]. One comparative advantage of these systems is that sequestration does not have to end at wood harvest. C storage can continue way beyond if boles, stems or branches are processed in any form of long-lasting products. More often, researchers estimate carbon by assuming the carbon content of dry biomass to be a constant 50% by weight [21]. However, other authors have used a carbon concentration of 45 % by weight [22]. In some cases, carbon is measured directly by burning the samples in a carbon analyzer [4]. Carbon values for the studied farms were derived by multiplying the obtained biomass values by 0.5 [23].

3. RESULTS AND DISCUSSION

3.1 Characterisation of the Studied Farms

Field data showed that in more than 90% of the farms, there were more than one tree species in association with annual crops (Table 1). Considering the major perennial crops, Cocoa was planted in most farms with an intercropped frequency of 74%. This was followed by Oil palm (56%) and the intercropped frequency for Rubber was 23% (Fig. 1a). This could be explained by the fact that Cocoa and Oil palm gets into maturity much earlier than Rubber, thus most farmers plant them to generate income earlier [24]. More to that, Oil palm can be consumed by farmers themselves and there are middlemen involved in buying of Oil and Cocoa bean thus making access to market easier. The farmers are paid as their produce is collected. On the other hand Rubber takes a longer time to reach maturity; its exploitation needs a specific skill which makes most small farmers not able to hire labour.

Marketing of Rubber involved mostly the agro industries who collect the crop and only pay some months after. Most of the other associated tree species are used either as wood (for example, Camwood, Small leaf, Iroko etc.) or as food (for example, Plum, Orange, Pear, pawpaw etc.) [25]. According to [26] plant species associated with Cocoa are largely the result of interactions between farmer preference, research recommendations and extension services. Generally, farmers place more importance on enhancing Cocoa production but also using the Cocoa farm to meet their daily household demands and need. The highly popular spice trees njangsang (*Ricinodendron heudelotii*) and Bush Mango (*Irvingia gabonensis*) were occasionally planted, but more often were retained or protected when they arise in a farm (Table1). This is similar to what was observed in the study on the Cocoa farms around the mount Cameroon region [27].

The low number of associated species in Oil Palm and Rubber farms compared to cocoa farms (Fig. 1b) could be attributed to the fact that cocoa tolerates shade while Oil Palm and Rubber form shades which reduce the growth of associated species.

3.2 Carbon Content in above Ground Biomass

The carbon stock depends on the plant species [2]. The carbon stocks per farm for each agroforestry system are presented below; carbon from the major plant species (Cocoa, Oil palm and Rubber) as well as the carbon contributed by the associated plant species (others) for the studied farms.

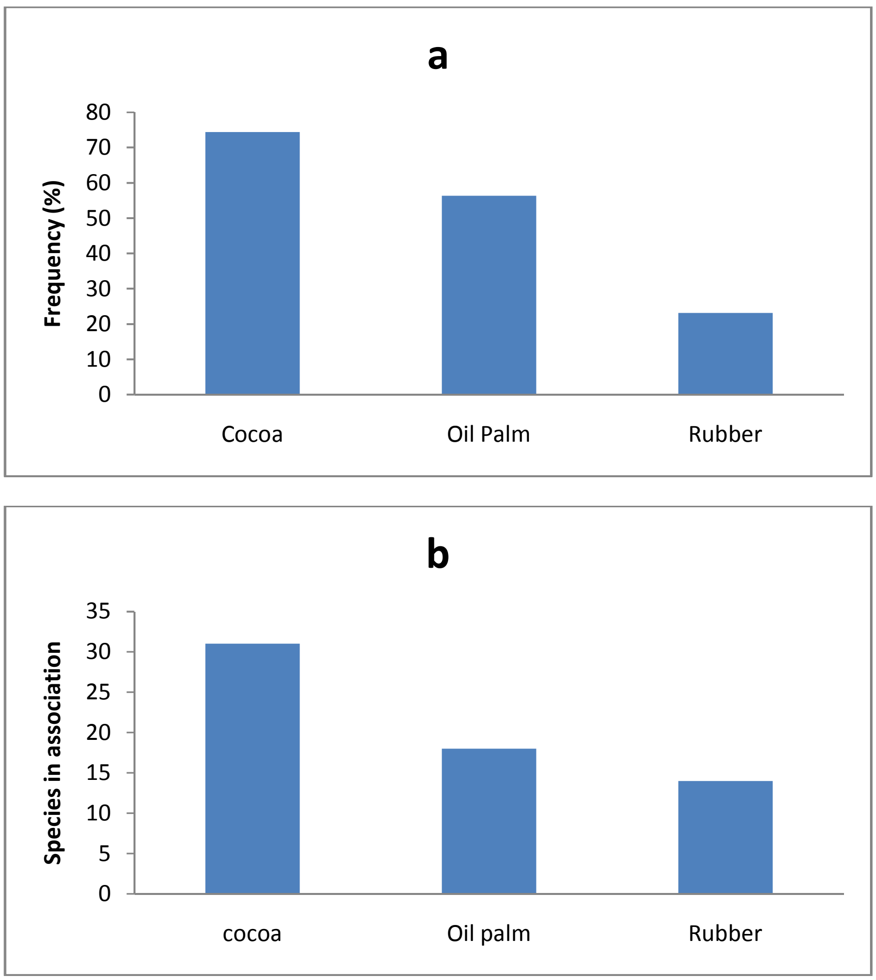

Fig. 1. Frequency of occurrence of cocoa, oil palm and rubber (a) and different species (b) in the studied farms

3.2.1 Cocoa based agroforestry system

The carbon content per farm is presented on Fig. 2 and it ranged from 44.59 Mg C/ha to 217.69 Mg C/ha for cocoa and 0.5 Mg C/ha to 20.3 Mg C/ha for the associated species. An average value for the farms could represent an ideal situation for home gardens in this region. The average per farm value of carbon was 57.16±53.07 Mg C/ha for the above ground biomass when the biomass was combined for the major and associated species for each farm. The high standard deviation shows that the farms varied much in their carbon content and this could be attributed to the tree density, tree age as well as the differences in the associated species. This average value is close to the value of 52.7±7.8 Mg C/ha that was obtained in cocoa Agroforestry system in the Sumaco Biosphere Reserve, Ecuador [28]. The results of this study are in line with 49 Mg/ha of carbon that was stored in the above ground biomass in cocoa agroforestry systems of Central America [29]. According to the study by [30] who evaluated the carbon stocks and sequestration potential in aboveground biomass in smallholder farming systems of western Kenya, an average per farm value of 6.5 Mg C/ha in Vihiga and 12.4 Mg C/ha in Siaya was obtained. All these values were lower than those obtained in this study. This could be attributed to soil and climate characteristics. Biomass C stock ranged from 0.7 to 54.0 Mg C/ha for a study on Carbon stock and sequestration potential of traditional and improved agroforestry systems in the West African Sahel [31]. The carbon stock of above ground biomass of this study is within this range for most of the studied farms.

As shown in Fig. 2, most of the carbon in the cocoa agroforestry system was contributed by the cocoa trees with associated species contributing very little. This observation is different from a study that found that most of the carbon in cocoa agroforests of Central Cameroon was contributed by associated trees [32]. This could be attributed to a greater number of immature cocoa trees in their study compared to the present study.

3.2.2 Oil palm based agroforestry system

The values of carbon content of the individual farms are presented in Fig. 3. The highest value of carbon stock was 138.06 Mg C/ha and the lowest was 0.34 Mg C/ha for oil palm and for the associated plant species the values ranged from 0 Mg C/ha to 46.55 Mg C/ha. The majority of the carbon in this system was contributed by the Oil palm with the associated species contributing very little to carbon stocks of this system. The high carbon content of Oil palm could be attributed to the fact that Oil palm trees are usually very tall compared to most other species. In association with other species, Oil palm shade them and reduce their growth rate hence reducing the amount of carbon in them. The high discrepancy in the carbon content could be attributed to the ages of the farms which ranged from immature to mature. Another factor is the number of plants per farm which varied much, the higher the tree density, the higher the carbon stock [5]. The number of plants planted was

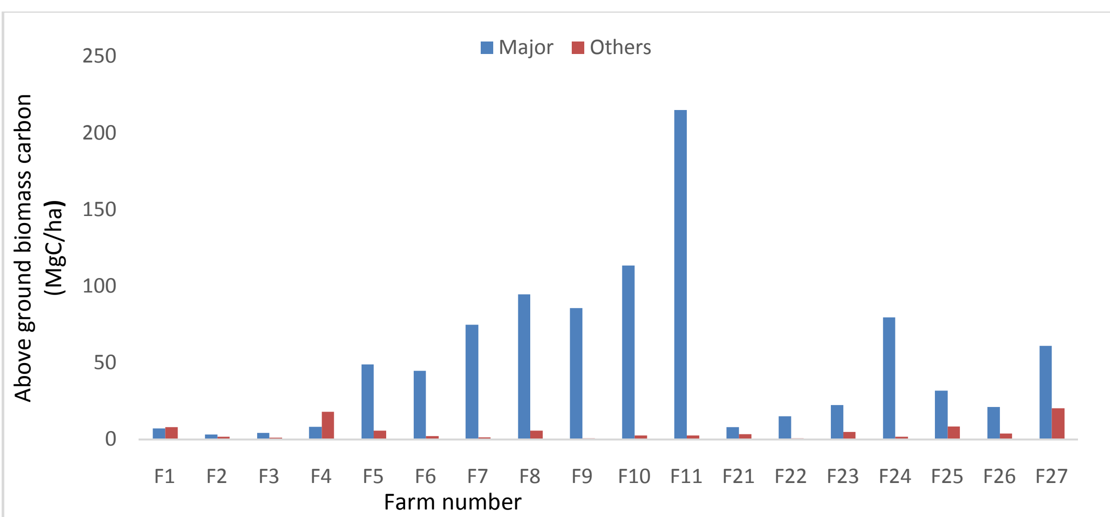

Fig. 2. Above ground biomass carbon in cocoa based agroforestry system

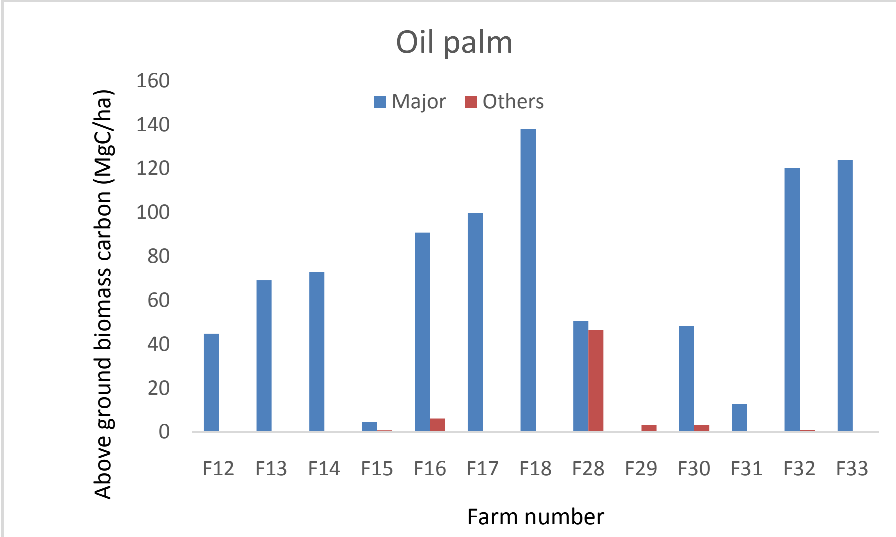

Fig. 3. Above ground biomass carbon in oil palm based agroforestry system

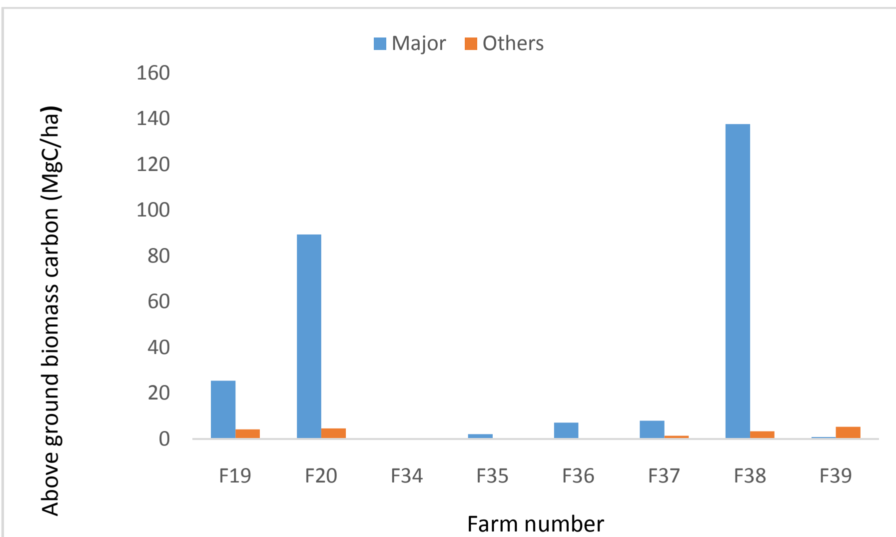

Fig. 4. Above ground biomass carbon in rubber based agroforestry system

based on the farmers' preference for the crop. In order to diversify income, most farmers prefer to plant more food crops for their family consumption; to meet the immediate needs of the family. The average carbon content of the above ground biomass for the farms studied (Oil palm and other species) was 72.17±45.95 Mg C/ha. This value is close to the 42.5 Mg C/ha obtained from a biomass of 85 t/ha obtained for mature Oil palms [20]. However the value obtained in this study may be an over estimation because the allometric equation used for the calculation of the above ground biomass considered all the palms as matured trees whereas they were not.

3.2.3 Rubber based agroforestry system

As shown on Fig. 4 (above), the carbon content of the above ground biomass ranged from 0.33 Mg C/ha to 137.55 Mg C/ha for rubber and 0.01 Mg C/ha to 5.33 Mg C/ha for the associated perennial species. This wide variation in carbon per farm is due to the age of the trees and the number of plants per farm. The average carbon for the farms when the carbon was combined for the rubber and other perennial species was 36.27±52.35 Mg C/ha. This value is not significantly different from 59 Mg C/ha estimated in agroforestry systems in sub-Saharan Africa [33]. In the said study, agroforestry systems in sub-Saharan Africa were said to accumulate 52.6 Pg C in woody biomass, above and belowground. However, in the present study only the above ground biomass was considered. The mean carbon value obtained for this study is equally higher than the estimates of 4.5 to 19 Mg C/ha obtained in another study [7]. Nonetheless, the authors acknowledged that their values were under estimated. The high variation in the carbon content per farm could be attributed to the differences in the number of trees in the farm and the age of the trees. In this agroforestry system, most of the carbon was contributed by the major crop; rubber. This is because rubber trees grow tall and shade most other trees thus reducing their growth. Farms 38 and 20 had matured trees and thus accumulated the highest amount of carbon.

Comparing the various agroforestry systems, Oil palm accumulated the highest carbon, followed by rubber and lastly by Cocoa (respectively, 72.45, 36.27 and 6.23 Mg C/ha). These values are within 4.5 and 19 Mg C/ha obtained for agroforestry systems in Sub-Saharan Africa [6]. The contribution of other perennial species to the carbon content of the three agroforestry systems was highest in Cocoa based agroforestry system with the associated species contributing a substantial amount of carbon. This was attributed to the fact that Cocoa tolerates shade and thus the associated species grow tall to provide this shade.

4. CONCLUSION

The carbon stock in the above ground biomass of some perennial crop based agroforestry systems was studied. The highest values of carbon were obtained for Oil palm based agroforestry system with an average of 72.5 Mg C/ha followed by Cocoa (57.16 Mg C/ha) and lastly by Rubber (36.27 Mg C/ha). For a given agroforestry system, the carbon stock per unit farm varied greatly due to the difference in the age of the farms and the number of trees per farm. The allometric equations for the estimation of biomass need to be developed for this region in order to get more reliable results. These agroforestry systems present a great potential for carbon storage besides providing food and income for small farmers.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Appendix 1. Plant species involved in this study

Common name	Scientific name
Njangsang	*Ricinodendron heudelotti*
Bush Mango	*Irvingia gabonensis*
Umbrella stick'	*Musanga cecropiodes*
Cocoyams	*Colocasia* spp.
Plantains	*Musa paradisiaca*
Cassava	*Manihot esculenta*
Maize	*Zea mays*
Pineapple	*Ananas comosus*
Banana	*Musa sapientum*
Kaso	*Tetracarpidium conophorum*
Orange	*Citrus sinensis*
Mango	*Mangifera indica*
Pawpaw	*Carica papaya*
Avocado	*Persea americana*
Plum (Bush Plum0	*Canarium schweinfurthii*
Oil palm	*Elaeis guineensis*
Raphia palm	*Raphia hookeri*
Kola nut	*Cola acuminata*
Iroko	*Milicia excelsa*
Mahogany	*Entandrophragma cylindricum*
Camwood	*Pterocarpus soyauxii*
Whitewood	*Strombosia pustulata*
Small leaf	*Albizia zygia*
Boma	*Ceiba pentandra*
Lemon	*Citrus* spp.
Monganga	*Ocotea usambarensis*
Coffee	*Coffea arabica*
Monkey no climb	*Distemonanthus benthamianus*
Bush coffee	*Coffea* spp.
Cotton tree	*Ceiba Pentandra*
Sweet Potatoes	*Ipomea* sp.
Okoro	*Abelmosehus esculentus*
Groundnuts	*Arachis hypogaea*
Morelle	*Night shade*
Eggplant	*Solanum melogena*
Pepper	*Capsicum annuum*
Taro	*Colocosia esculenta*
Yam	*Dioscorea* spp
Cocoa	*Theobroma cacao*
Christmas bush	*Alchornea cordifolia*
Jew's mallow, or Tossa jute *or* Bush	*Corchorus olitorius*
Rubber	*Hevea brasiliensis*

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