ECOLOGICAL SURVEY OF COMMERCIALLY VALUED RAINFOREST TREES IN COCOA PLANTATIONS IN CROSS RIVER STATE, NIGERIA

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ABSTRACT

The study was designed to identify, enumerate and collate information on the commercially valued rainforest tree species growing in cocoa plantations located in four local government areas (cocoa growing areas) of Cross River State, Nigeria, namely Akamkpa, Boki, Etung, and Ikom. Four 50 m x 50 m plots of cocoa plantations were randomly laid for data collection in each of the randomly selected cocoa growing areas. A total of 286 trees species were identified and enumeratedwhile180 were commercially valued rain forest trees. The stand distributions were examined by classifying the trees into diameter-classes. All the trees encountered were identified and measured for diameter at breast height (1.3 m) using diameter tape. The five diameter classes were recorded as follows: 10-20 cm (class 1); 20-30 cm (class 2); 30-40 cm (class 3); 40-50 cm (class 4); 50-60 cm (class5) and 60 cm above (class 6). The economic importance of each species was identified. The basal areas of each species were calculated to determine the density. The result showed that diameter class six (6) had the highest diameter values of 56 m^2, 29 m^2, 28 m^2 and 19 m^2 for Ikom, Etung, Akamkpa and Boki cocoa plantation respectively, while the basal area (m^2per/ha) of all trees (pooled) in each of the plantations valued was 67.49 m^2, 517.47 m^2, 3093.30 m^2 and 603.49 m^2respectively. These commercially valued rainforest tree species in cocoa plantations studies are many and of standard sizes. It is recommended that they should be conserved for sustainable future utilization.

Keywords: Rainforest Tree, Commercially Valued Trees, Conservation, Protection, Cocoa

INTRODUCTION

A lot of valuable rainforest tree species are on the verge of extinction occasioned by widespread habitat destruction and logging of the rainforest. Recently, efforts are being geared towards conserving the tree species to prevent utter loss of their genetic resources. Traditional agroforestry practice in the form of cocoa farming has been found as a way of protecting and conserving most of the threatened species by allowing them to grow in cocoa plantations. The tropical rainforest constitutes just about 2% of Nigerian's total land area and is the source of the bulk of timber needs of the country (Ajakaye, 2001; Akinsanmi and Akindele, 2002). The demand for the wood products from timber trees of rainforest origin is constantly high locally and internationally. Quite a number of these tree species are threatened with extinction stemming from indiscriminate exploitation and alarming rate of rainforest destruction. The Nigerian rainforest contains over 560 tree species which attain a height of at least 12m and a girth of 60cm when mature (Akachuku, 1997a and b) tree species were classified as follows, class 1; species of major economic timber importance are (22 species), class ii: species of lesser importance (28 species); class iii; species of possible timber importance (35 species) and class iv; species likely to be only of use for fuel, charcoal or industrial use are mainly (under-storey species). The Cross River state rainforest is an integral part of the world tropical rainforest. And it covers the largest land mass of 7290 km^2 (34.3%) in its grading. In addition to the rainforest, are swamp forest with 520 km^2, (2.5%), mangrove forest : 480 km^2 (2.2%), oil palm plantation : 219 km^2 (1.0%), rubber plantation: 145 km^2 (0.7%), gmelina plantation : 95 km^2(0.5%) and landuse for farming: 12,516 km^2 (58.8%) with a total landmass of 21,265 km^2 (Effa and Ogar, 1994). The tropical rainforest is the most biologically diverse ecosystem on earth (Adedire, 1992). Currently the tropical rainforest is faced with threat of massive deforestation, destruction and over exploitation of timber and non-timber forest products. Thus most of the rainforest products have gone extinct; thereby endangering the survival of man and other organisms. Cocoa farms in West Africa structurally provide multi-strata systems with a horizontal and vertical distribution of tree species components which represent an important factor in sustaining the cocoa. In this stratified multi-cohort system, native timber trees occupy the upper canopy (under storey) with cocoa and other fruit trees occupying the lower canopy. The pre-existing vegetation before the establishment of a cocoa farm or agro forest plays a vital role in the structure, since some trees are left at the early stage of the plantation. The structural arrangement or the multi-strata system offers farmers the opportunity to exploit all the necessary components in the system (Rice and Greenberg, 2000). The integration of suitable and valuable forest tree species at various stages and levels of cocoa farm is a widespread practice in smallholder

cocoa farms in West Africa. The under listed preferred trees are combined with cocoa trees, and protected, conserved for future uses.

* *Milicia excelsa* - Nurtured for timber and shade

* *Antiaris species* - Nurtured for timber and shade

* *Lovoatrichioides* - Nurtured for wood and shade

* Other tree species conserved in cocoa farm include *Irvingia gabonesis, Dacryodeseduli, Manoteraintica, Perscea americana* and *arthocarpusaltilis*

* *Terminalia superba* - shade and timber

* *Lophiraalata* -Nurtured for shade

* *Elaies guinensis* - home consumption (Palm oil).

In industrialized countries, farmers list shade and shelter, soil protection and improvement of the landscape and rural environment as their main reasons for growing trees (Auclair *et al*., 2000). In the tropics, farmers grow woody species for security and subsistence. The mixture of natural forest tree species such as fruit tree species, timber species, semi-cultivated woody plants (*Elaeis guinensis*) and cultivated plants (cocoa and bananas), representing high level of plant diversity, and conservation value (Zapfack *et al*., 2002; Bobo *et al*., 2006; Merijn *et al*. 2007; Sonwa *et al*., 2007). Their adaptive nature offers options for combining biodiversity Conservation and Production for human benefits (Greenberg *et al*., 2000; Reitsma *et al*., 2001; Perfecto *et al*., 2005; MCNeely and Schroth, 2006; Gordon *et al*., 2007; Steffan-Dewenter *et al*., 2007).

MATERIALS AND METHODS

Study area

The study was carried out in four cocoa plantations in the tropical rainforest areas namely Akamkpa Local Government Area - In Ette Asong cocoa plantation (Latitude 05.57’20N and Longitude 08.37’18E), Boki Local Government Area - NtahBessong cocoa plantation (latitude 06.00’27 N and longitude 08.33’37E); Etung Local Government Area - Cocoa Research Institute of Nigeria (CRIN) cocoa plantation (Latitude 05.57’03’N and Longitude 08.37’58’E) and IkomLocal Government Area- Abia cocoa plantation (Latitude 05.54’02N and longitude 08.35’32E).The soil of the area is podzolic and lateritic. Thus very rich in iron oxides, kadin clay and compounds, due to heavy leaching caused by very high annual rainfall (Asuquo, 1987). These areas are in the tropical rainforest zone with annual rainfall ranging between 2000 and 3000 mm. The annual temperatures range between 25^0C and 27^0C, while the relative humidity is 80-90% at every six (6) hours (Asuquo, 1987).

Data collection

Four adjoining cocoa plantations were identified measured had sizes between 10.2 ha and 12.5 ha, and were randomly selected for data collection. A line transect was laid across each cocoa plantation and thereafter, four 50 m x 50 m sample plots were laid at randomly selected points along each of the line transects. The cocoa plantations were between 18 and 27 years old. All the primary rainforest trees with diameter at breast height (dbh) > 10cm in all the sample plots were identified and enumerated.

Data analysis

The population density of individual tree species encounter was estimated on per/ha basis from the total area sampled, which was four hectares. Stem diameter distribution of the trees was analyzed according to the following classification: 10-20 cm (class 1), 21-30 cm (class 2), 31-40 cm (class 3), 41- 50 cm (class 4), 51-60 cm (class 5), 61-70 cm (class 6), 71-80 cm (class 7), 81-90 cm (class 8), 91-100 cm (class 9) and above100 cm (class 10). The basal area of each tree was calculated from the dbh measurement using formula: $BA = \frac{\pi D^2}{4}$ Where, BA = Basal Area, D = Diameter at breast height, = constant (3.142).

Results

A total of 286 trees species belonging to various families were encountered in the study area (Tables 1, 2, 3, 4) and 180 were commercially valued rain forest trees. *Irvingia gabonesis* (Bush Mango tree) had the highest population density of 40 ha^{-1}, while *Entandrophragma cylindricum* (Sapele wood), *Pterocarpus osun* (Red wood), and *Khaya ivorensis* (Mahogany) had the least value of 1 ha^{-1} (Tables 1, 2 and 3). Thirty-three percent (33%) of the forest trees were of small diameter sizes of between 20 - 30 cm (Table 2). The highest basal area of forest trees in each of the cocoa plantations were measured and recorded as follows: *Brackystigia eurycoma* with 3.03 m^2 per ha, *Irvingia gabonensis* 8.09 m^2 per ha, *Ciebapentandra* 94.88 m^2 per ha, and *Khaya ivorensis*15.40 m^2 per ha (Table 9,10,11,12) respectively.

Table 1: Rainforest Trees in Ette Asong Cocoa Plantation – Akamkpa Local Government Area

S/N	Name of Species	Common Name	Pop/Ha	Economic Importance	Family Name
1	*Irvingia gabonensis*	Bush mango tree	11	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Irvingiaceae
2	*Brackystigiaeurycoma*	Achi/'ntan' tree	4	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	-
3	*Mangifera indica*	Mango tree	5	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Anacardiaceae
4	*Lophiraalata*	Iron wood tree	2	Timber, fuel wood, shade, windbreak, and erosion control	-
5	*Entandrophragma cylindricum*	Sapele	1	Timber, fuel wood, shade, windbreak, and erosion control	Meliaceae
6	*Pterocarpus osun*	Red camwood	1	Timber, fuel wood	Fabaceae
7	*Terminalia superba*	Africa yield wood	4	Timber, fuel wood, shade, windbreak, and erosion control	Combretaceae
8	*Gmelina arborea*	Gmelina tree	3	Timber, fuel wood, shade, windbreak, and erosion control	-
9	*Dacryodes edulis*	African pear tree	5	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	-
10	*Citrus sinensis*	Orange tree	8	Fuel wood, fruit as food, shade, windbreak, and erosion control	Rutaceae
11	*Ceiba pentandra*	Cotton tree	6	Timber, fuel wood, shade, windbreak, and erosion control	-
	Total		50		

Table 2: Rainforest Trees in NtahBessong Cocoa Plantation – Boki Local Government Area

S/N	Name of Species	Common Name	Pop/Ha	Economic Importance	Family Name
1	*Acacia sinensis*	Acacia	20	Timber, fuel wood, shade, windbreak, and erosion control	Fabaceae
2	*Dacryodes edulis*	African pear tree	8	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	-
3	*Ceiba pentandra*	Cotton tree	7	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	-
4	*Antoclestrial vulgelii*	Guttex tree	12	Timber, fuel wood, shade, windbreak, and erosion control	-
5	*Khaya ivorensis*	Mahogany	1	Timber, fuel wood, shade, windbreak, and erosion control	Meliaceae
6	*Pterocarpus lucens*	Atrukpa tree	9	Timber, fuel wood	Fabaceae
7	*Irvingia gabonensis*	Bush mango	13	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Irvingiaceae
8	*Anacardium occidentale*	Cashew tree	2	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Anacardiaceae
9	*Persea americana*	Avocado pear	1	Timber, fuel wood, fruit as food, shade, windbreak,	Lauraceae

				and erosion control	
10	*Mangifera indica*	Mango tree	2	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Anacardiaceae
11	*Brackystigiaeurycoma*	Achi tree	4	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	-
12	*Citrus sinensis*	Orange tree	5	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Rutaceae
13	*Tectona grandis*	Teak tree	3	Timber, fuel wood, shade, windbreak, and erosion control	Lamiaceae
14	*Terminalia catappa*	Almond tree	3	Timber, fuel wood, shade, windbreak, and erosion control	Combretaceae
	Total		90		

Table 3: Rainforest Trees in Cocoa Research Institute of Nigeria (CRIN) cocoa plantation – Ikom Local Government Area

S/N	Name of Species	Common Name	Pop/ Ha	Economic Importance	Family Name
1	*Lovoatrichilioides*	Ceda tree	5	Timber, fuel wood, shade, windbreak, and erosion control	Meliaceae
2	*Sterculia oblonga*	Yellow sterculia	4	Timber, fuel wood, shade, windbreak, and erosion control	-
3	*Mangifera indica*	Mango tree	3	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Anacardiaceae
4	*Milicia excels*	Iroko tree	3	Timber, fuel wood, shade, windbreak, and erosion control	-
5	*Ceiba pentandra*	Cotton tree	8	Timber, fuel wood, shade, windbreak, and	-

				erosion control	
6	*Lophiraalata*	Iron wood tree	8	Timber, fuel wood, shade, windbreak, and erosion control	-
7	*Artocarpus heterophyllus*	African breadfruit	6	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	-
8	*Elaeisguineensis*	Palm tree	1	Fuel wood, fruit as food, shade, windbreak, and erosion control	Arecaceae
9	*Dacryodes edulis*	African pear tree	10	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	-
10	*Entandrophragma cylindricum*	Sapele tree	4	Timber, fuel wood, shade, windbreak, and erosion control	Meliaceae
11	*Antoclestrial vulgelii*	Guttex	14	Timber, fuel wood, shade, windbreak, and erosion control	-
12	*Irvingiagabonensis*	Bush mango	12	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Irvingiaceae
13	*Garcinia kola*	Bitter kola	3	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	-
	Total		80		

Table 4: Rainforest Trees in - Abia Cocoa Plantation – Etung Local Government Area

S/N	Name of Species	Common Name	Pop/Ha	Economic Importance	Family Name
1	*Delonix regia*	Flame of the forest	3	Timber, fuel wood, shade, windbreak, and erosion control	-
2	*Pterocarpus lucens*	Atrukpa tree	2	Timber, fuel wood, shade, windbreak, and erosion control	Fabaceae
3	*Ceiba pentandra*	Cotton tree	4	Timber, fuel wood, shade, windbreak, and erosion control	-
4	*Bracky stigiaeurycoma*	Achi tree	2	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	-
5	*Irvingia gabonensis*	Bush mango	4	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Irvingiaceae
6	*Gmelina arborea*	Gmelina tree	1	Timber, fuel wood, shade, windbreak, and erosion control	-
7	*Azadirachta indica*	Neem tree	3	Timber, fuel wood, shade, windbreak, and erosion control	-
8	*Artocarpus heterophyllus*	African breadfruit	4	Timber, fuel wood, fruit as food, shade, windbreak, and	-

				erosion control	
9	*Milicia excelsa*	Iroko tree	3	Timber, fuel wood, shade, windbreak, and erosion control	Meliaceae
10	*Terminalia catappa*	Almond tree	4	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Combretaceae
11	*Mangifera indica*	Mango tree	2	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	Combretaceae
12	*Khaya ivorensis*	Mahogany tree	2	Timber, fuel wood, shade, windbreak, and erosion control	Meliaceae
13	*Lophira alata*	Iron tree	3	Timber, fuel wood, shade, windbreak, and erosion control	-
14	*Dacryodes edulis*	African pear tree	6	Timber, fuel wood, fruit as food, shade, windbreak, and erosion control	-
15	*Antoclestrial vulgelii*	Guttex	6	Timber, fuel wood, shade, windbreak, and erosion control	-
16	*Musangacecropioides*	Umbrella tree	5	Timber, fuel wood, shade, windbreak, and erosion control	-
17	*Rauvolfia vomitoria*	Swizzle stick	6	Timber, fuel wood, shade, windbreak, and erosion control	Rosaceae
18	*Hura crepitans*	Sandbox tree	4	Timber, fuel wood, shade, windbreak, and erosion control	-
19	*Calophyllum inophyllum*	Ball tree / Dilo oil tree	2	Timber, fuel wood, shade, windbreak, and erosion control	Clusiaceae
20	*Chrysophyllum albidum*	Star apple	2	Timber, shade, windbreak, and erosion control	-
	Total		66		

Table 5: Stem Diameter Distribution of Rainforest Trees in Ette Asong Cocoa plantation – Akamkpa Local Government Area

S/N	Tree Species	Diameter Classes					
		1	2	3	4	5	6
1	*Acacia sinensis*	7	3	6	5	-	1
2	*Dacryodes edulis*	2	2	4	-	-	-
3	*Ceiba pentandra*	-	3	3	1	-	-
4	*Antoclestrialvulgelii*	4	8	-	-	-	-
5	*Khaya ivorensis*	1	-	-	-	-	-
6	*Pterocarpus lucens*	4	4	1	1	-	-
7	*Irvingiagabonensis*	1	5	4	3	-	-
8	*Anacardium occidentale*	1	1	-	-	-	-
9	*Persea americana*	-	-	-	-	-	-
10	*Mangifera indica*	1	1	1	1	-	-
11	*Brackystigia eurycoma*	1	2	-	-	-	-
12	*Citrus sinensis*	4	1	1	1	1	-
13	*Tectona grandis*	-	-	-	-	-	-
14	*Terminalia catappa*	1	1	1	-	-	-
	Sub-total	**27**	**31**	**21**	**12**	**1**	**1**
	Total						**93**

Table 6: Stem Diameter Distribution of Rain Forest Trees in NtahBessong Cocoa plantation – Boki Local Government Area

S/N	Tree Species	Diameter Classes					
		1	2	3	4	5	6
1	*Irvingia gabonensis*	-	2	5	-	1	4
2	*Brackystigia eurycoma*	-	-	-	-	-	4
3	*Mangifera indica*	1	2	-	1	-	2
4	*Lophiraalata*	-	-	-	-	1	1
5	*Terminalia superba*	-	1	1	-	-	2
6	*Entandrophragma cylindricum*	-	-	-	-	-	1
7	*Pterocarpus osun*	-	-	-	-	-	1
8	*Gmelina arborea*	-	-	-	1	1	1
9	*Dacryodes edulis*	1	-	2	-	-	3
10	*Citrus sinensis*	1	4	4	1	-	-
11	*Ceiba pentandra*	-	4	1	-	-	2
	Sub-total	3	13	13	3	3	21
	Total						**56**

Table 7: Stem Diameter Distribution of Rainforest Trees in Cocoa Research Institute of Nigeria (CRIN) cocoa plantation – Ikom Local Government Area

S/N	Tree Species	Diameter Classes					
		1	2	3	4	5	6
1	Lovoatrichiloides	-	-	-	3	-	2
2	Sterculia oblonga	-	1	1	-	-	2
3	Mangifera indica	-	-	-	-	-	3
4	Milicia excels	1	-	1	-	-	1
5	Garcinia kola	2	1	1	-	-	-
6	Artocarpus heterophyllus	-	1	-	1	-	4
7	Ceiba pentandra	-	-	-	-	-	8
8	Lophiraalata	1	1	2	-	1	3
9	Dacryodes edulis	-	1	-	2	-	9
10	Entandrophragmacylindricum	-	-	-	-	-	4
11	Antoclestrialvulgelii	-	1	1	2	1	11
12	Irvingiagabonensis	1	2	2	1	1	8
13	Elaeisguineensis	-	-	-	-	-	1
	Sub-total	5	8	8	9	3	46
	Total						**79**

Table 8: Stem Diameter Distribution of Rainforest Trees in - Abia Cocoa Plantation – Etung Local Government Area

S/N	Tree Species	Diameter Class 6					
		1	2	3	4	5	6
1	*Delonixrigia*	-	-	-	1	-	2
2	*Pterocarpus lucens*	1	-	-	-	-	-
3	*Ceiba pentandra*	1	1	-	-	-	3
4	*Hura crepitans*	1	-	-	1	-	2
5	*Brackystigiaeurycoma*	-	-	-	-	-	2
6	*Calophylluminophyllum*	-	-	-	-	-	2
7	*Gmelina arborea*	-	-	-	-	-	1
8	*Chrysophyllum albidum*	-	-	1	-	-	1
9	*Azadirachta indica*	1	-	-	1	-	1
10	*Artocarpus heterophyllus*	-	-	1	-	1	2
11	*Milicia excels*	-	-	-	1	1	1
12	*Terminalia catappa*	-	2	-	2	-	-
13	*Mangifera indica*	-	-	-	-	1	3
14	*Khaya ivorensis*	-	1	-	-	-	1
15	*Lophiraalata*	2	1	1	1	1	-
16	*Rauvolfia vomitoria*	-	-	-	-	1	3
17	*Musangacecropioides*	-	-	1	-	2	2
18	*Irvingiagabonensis*	-	-	-	2	1	1
19	*Antoclestrialvulgelii*	1	-	1	2	1	1
20	*Dacryodes edulis*	1	2	-	-	2	1
	Sub-total	8	7	5	11	11	29
	Total						71

Table 9: Basal Area of Rainforest Trees in Ette Asong Cocoa Plantation – Akamkpa Local Government Area

S/N	Tree Species	Basal area (m^2)	
1	*Acasia sinensis*	1.32	
2	*Dicryoides edulis*	0.28	
3	*Acasia sinensis*	0.33	
4	*Acasia sinensis*	0.95	
5	*Acasia sinensis*	1.77	
6	*Ceiba pentandra*	0.72	
7	*Ceiba pentandra*	0.72	
8	*Acasia sinensis*	(a) 0.33 (b) 0.19 (c) 0.13	Trees standing at the same spot or a single tree with branches below breast height
9	*Acasia sinensis*	1.30	
10	*Acasia sinensis*	1.18	
11	*Acasia sinensis*	1.07	
12	*Acasia sinensis*	1.56	
13	*Acasia sinensis*	0.73	
14	*Acasia sinensis*	1.24	
15	*Ceiba pentandra*	1.77	

16	*Acasia sinensis*	0.42
17	*Ceiba pentandra*	0.62
18	*Dicryoides edulis*	0.63
19	*Antoclestrialvulgelii*	0.36
20	*Irvingiagabonensis*	1.18
21	*Pterocarpus lucens*	1.49
22	*Acasia sinensis*	0.09
23	*Antoclestrialvulgelii*	0.09
24	*Antoclestrialvulgelii*	0.48
25	*Magnifera indica*	0.86
26	*Pterocarpus lucens*	0.95
27	*Acasia sinensis*	0.09
28	*Acasia sinensis*	1.15
29	*Irvingiagabonensis*	1.54
30	*Dicryoides edulis*	0.72
31	*Antoclestrialvulgelii*	0.42
32	*Antoclestrialvulgelii*	0.29
33	*Dicryoides edulis*	0.76
34	*Pterocarpus lucens*	0.36
35	*Pterocarpus lucens*	0.09
36	*Acasia sinensis*	0.08
37	*Magnifera indica*	5.17
38.	*Acasia sinensis*	1.26
39	*Citrus sinensis*	0.95
40	*Brackystigiaeurycoma*	0.81
41	*Dicryoides edulis*	0.33
42	*Dicryoides edulis*	1.24
43	*Irvingiagabonensis*	0.62
44	*Terminalia catappa*	1.02
45	*Citrus sinensis*	0.09
46	*Acacia sinensis*	3.12
47	*Tectona grandis*	0.72
48	*Ceiba pentandra*	0.53
49	*Brackystigiaeurycoma*	0.29
50	*Irvingiagabonensis*	0.33
51.	*Irvingiagabonensis*	1.43
52	*Brackystigiaeurycoma*	3.03
53.	*Dicryoides edulis*	0.99
54.	*Irvingiagabonensis*	1.02
55	*Pterocarpus lucens*	0.69
56	*Khaya ivorensis*	0.10
57	*Irvingiagabonensis*	0.66
58	*Acasia sinensis*	0.27
59	*Pterocarpus lucens*	0.43
60	*Antoclestrialvulgelii*	0.33
61	*Antoclestrialvulgelii*	0.46
62	*Pterocarpus lucens*	0.12
63	*Antoclestrialvulgelii*	0.09
64	*Irvingiagabonensis*	1.24
65	*Irvingiagabonensis*	0.33
66	*Persea Americana*	0.15
67	*Acasia sinensis*	0.15
68	*Antoclestrialvulgelii*	0.50
69	*Ceiba pentandra*	0.89
70	*Anacardium occidentale*	0.21
71	*Irvingiagabonensis*	1.43
72	*Anacardium occidentale*	1.70
73	*Antoclestrialvulgelii*	0.37
74	*Pterocarpus lucens*	0.15
75	*Terminalia catappa*	0.33

76	*Antoclestrialvulgelii*	0.56
77	*Terminalia catappa*	0.56
78	*Irvingiagabonensis*	0.11
79	*Citrus sinensis*	0.35
80	*Brackystigia eurycoma*	0.93
81	*Tectona grandis*	0.32
82	*Citrus sinensis*	(a) 0.11 (b) 0.15 — Trees standing at the same spot or a single tree with branches below breast height
83	*Irvingia gabonensis*	0.39
84	*Citrus sinensis*	0.24
85	*Irvingia gabonensis*	0.78
86	*Dicryoides edulis*	0.30
87	*Pterocarpus lucens*	0.33
88	*Antoclestrialvulgelii*	0.15
89	*Pterocarpus lucens*	0.39
90	*Ceiba pentandra*	0.33
Total	**Tress number = 90**	**67.49**

Table 10: Basal Area of Rainforest Trees in NtahBessong Cocoa Plantation – Boki Local Government Area

S/N	Tree Species	Basal area (m^2)
1	*Irvingia gabonensis*	0.39
2	*Magniferaindicca*	0.09
3	*Dicryoides edulis*	0.29
4	*Irvingia gabonensis*	1.02
5	*Irvingia gabonensis*	0.95
6	*Citrus sinensis*	0.89
7	*Magnifera indica*	(a) 4.28 (b) 1.91 — Trees standing at the same spot or a single tree with branches below breast height
8	*Terminalia superba*	6.24
9	*Gmelina arborea*	1.30
10	*Dicryoides edulis*	0.95
11	*Irvingiagabonensis*	0.39
12	*Citrus sinensis*	0.19
13	*Citrus sinensis*	(a) 0.53 (b) 0.66 — Trees standing at the same spot or a single tree with branches below breast height
14	*Lophiraalata*	2.17
15	*Ceiba pentandra*	0.57
16	*Ceiba pentandra*	0.53
17	*Terminalia superba*	0.86
18	*Citrus sinensis*	(a) 1.18 (b) 0.53 — Trees standing at the same spot or a single tree with branches below breast height
19	*Magnifera indica*	0.42
20	*Irvingiagabonensis*	(a) 0.91 (b) 1.18 — Trees standing at the same spot or a single tree with branches below breast height
21	*Dicryoides edulis*	0.86

22	*Magnifera indica*	0.33	
23	*Ceiba pentandra*	0.46	
24	*Citrus sinensis*	0.66	
25	*Irvingiagabonensis*	0.86	
26	*Irvingiagabonensis*	4.06	
27	*Terminalia superba*	3.31	
28	*Irvingiagabonensis*	2.49	
29	*Ceiba pentandra*	(a) 32.59 (b) 13.38	Trees standing at the same spot or a single tree with branches below breast height
30	*Brackystigiaeurycoma*	52.46	
31	*Brackystigiaeurycoma*	138.63	
32	*Lophiraalata*	4.14	
33	*Gmaelina arborea*	4.81	
34	*Entanndrophragmacylindricum*	6.24	
35	*Dicryoides edulis*	10.66	
36	*Terminalia superb*	0.46	
37	*Citrus sinensis*	1.13	
38	*Pterocarpus osun*	5.21	
39	*Citrus sinensis*	1.30	
40	*Ceiba pentandra*	0.66	
41	*Irvingiagabonensis*	29.51	
42	*Magnifera indica*	7.45	
43	*Irvingiagabonensis*	8.09	
44	*Brackystigiaeurycoma*	53.76	
45	*Irvingiagabonensis*	5.71	
46	*Ceiba pentandra*	1.02	
47	*Citrus sinensis*	0.78	
48	*Gmaelina arborea*	2.49	
49	*Dicryoides edulis*	(a) 18.33 (b) 12.86	Trees standing at the same spot or a single tree with branches below breast height
50	*Brackystigiaeurycoma*	11.25	
Total	**Number of tree = 50**	**517.47**	

Table 11: Basal Area of Forest Trees in Cocoa Research Institute of Nigeria (CRIN) Cocoa Plantation – Ikom Local Government Area

S/N	Tree Species	Basal area (m^2)
1	*Lovoatrichiliodes*	3.42
2.	*Garcina kola*	1.24
3	*Irvingiagabonensis*	31.08
4	*Dicryoides edulis*	11.19
5	*Entandrophragmacylindricum*	10.66
6	*Ceiba pentandra*	4.14
7	*Sterculia oblonga*	0.49
8	*Irvingiagabonensis*	14.31
9	*Lovoatrichiliodes*	1.30
10	*Sterculia oblonga*	20.86
11	*Lophiraalata*	16.47
12	*Magnifera indica*	36.04
13	*Milicia excels*	9.14
14	*Garcina kola*	0.27
15	*Magnifera indica*	23.89
16	*Lovoatrichiliodes*	14.51
17	*Lophiraalata*	1.03
18	*Artocarpus heterophyllus*	27.51
19	*Milicia excels*	0.19
20	*Entandrophragmacylindricum*	22.60
21	*Irvingiagabonensis*	(a) 0.76 (b) 1.24 Trees standing at the same spot or a single tree with branches below breast height
22	*Garcina kola*	(a) 0.66 (b) 0.19 Trees standing at the same spot or a single tree with branches below breast height
23	*Dicryioides edulis*	3.82
24	*Ceiba pentandra*	4.47
25	*Irvingiagabonensis*	11.37
26	*Irvingiagabonensis*	0.57
27	*Sterculia oblonga*	0.89
28	*Sterculia oblonga*	48.41
29	*Entandrophragmacylindricum*	195.13
30	*Dicryioides edulis*	81.97
31	*Lophiraalata*	21.43
32	*Antoclestrialvulgelii*	1.18
33	*Milicia excels*	1.22
34	*Antoclestrialvulgelii*	232.12
35	*Dicryioides edulis*	16.62
36	*Lophiraalata*	2.69
37	*Irvingiagabonensis*	23.89
38	*Lovoatrichiloides*	1.91
39	*Dicryioides edulis*	7.74
40	*Ceiba pentandra*	(a) 2.66 (b) 6.24 Trees standing at the same spot or a single tree with branches below breast height
41	*Antoclestrialvulgelii*	2.75
42	*Irvingiagabonensis*	1.30
43	*Antoclestrialvulgelii*	3.41
44	*Irvingiagabonensis*	85.40

45	*Antoclestrialvulgelii*	1.56	
46	*Artocarpus heterophyllus*	1.89	
47	*Lophiraalata*	0.95	
48	*Magnifera indica*	362.35	
49	*Antoclestrialvulgelii*	4.74	
50	*Lophiraalata*	3.61	
51	*Lovoatrichiloides*	1.56	
52	*Ceiba pentandra*	271.73	
53	*Irvingiagabonensis*	2.69	
54	*Antoclestrialvulgelii*	3.64	
55	*Dicryioides edulis*	18.95	
56	*Antoclestrialvulgelii*	1.28	
57	*Antoclestrialvulgelii*	(a) 388.71 (b) 170.54 (c) 549.52	Trees standing at the same spot or a single tree with branches below breast height
58	*Artocarpus heterophyllus*	4.47	
59	*Irvingiagabonensis*	9.25	
60	*Antoclestrialvulgelii*	4.74	
61	*Ceiba pentandra*	7.40	
62	*Antoclestrialvulgelii*	0.46	
63	*Dicryoides edulis*	(a) 1.84 (b) 0.39 (c) 2.84	Trees standing at the same spot or a single tree with branches below breast height
64	*Ceiba pentandra*	(a) 4.51 (b) 11.55	Trees standing at the same spot or a single tree with branches below breast height
65	*Elaiesguinensis*	26.39	
66	*Ceiba pentandra*	94.88	
67	*Lophiraalata*	0.33	
68	*Antoclestrialvulgelii*	12.48	
69	*Antoclestrialvulgelii*	3.61	
70	*Irvingiagabonensis*	3.61	
71	*Artocarpus heterophyllus*	4.74	
72	*Ceiba pentandra*	5.89	
73	*Didryoides edulis*	68.82	
74	*Entandrophragma cylindricum*	3.71	
75	*Dicryoides edulis*	4.21	
76	*Lophiraalata*	0.10	
77	*Antoclestrialvulgelii*	5.34	
78	*Artocarpus heterophyllus*	16.62	
79	*Irvingia gabonensis*	(a) 0.33 (b) 0.09	Trees standing at the same spot or a single tree with branches below breast height
80	*Artocarpus heterophyllus*	0.33	
Total	Number of tree = 80	3,093.30	

Table 12: Basal Area of Rainforest Trees in - Abia Cocoa Plantation – Etung Local Government Area

S/N	Tree Species	Basal area (m^2)
1	*Delonixrigia*	16.62
2	*Ceiba pentandra*	5.34
3	*Pterocarpus lucens*	0.10
4	*Pterocarpus lucens*	0.17
5	*Hura crepitana*	0.10
6	*Ceiba pentandra*	0.33
7	*Irvingiagabonensis*	129.96
8	*Delonixrigia*	6.24
9	*Terminalia vulgelii*	0.84
10	*Antoclestrialvulgelii*	0.13
11	*Hura crepitans*	18.95
12	*Rauvolfiavolmitoria*	2.69
13	*Magnifera indica*	(a) 73.33 (b) 18.03 — Trees standing at the same spot or a single tree with branches below breast height
14	*Azardirata indica*	28.93
15	*Calophylluminophyllum*	5.76
16	*Terminalia catappa*	0.81
17	*Irvingiagabonensis*	2.72
18	*Magnifera indica*	7.40
19	*Ceiba pentandra*	30.78
20	*Terminalia catappa*	0.35
21	*Terminalia catappa*	1.34
22	*Milicia excels*	46.19
23	*Antoclestrialvulgelii*	0.99
24	*Artocarpus heterophyllus*	32.98
25	*Musangacecropiodies*	0.73
26	*Lophiraalata*	2.14
27	*Azardirata indica*	1.91
28	*Dicryioides edulis*	0.66
29	*Ceiba pentandra*	16.62
30	*Milicia excels*	1.60
31	*Hura crepitan*	7.40
32	*Musangacecropioides*	3.41
33	*Irvingiagabonensis*	1.32
34	*Dicryioides edulis*	0.66
35	*Calophylluminophyllum*	14.51
36	*Artocarpus heterophyllus*	0.89
37	*Delonixrigia*	1.54
38	*Azardirata indica*	0.29
40	*Irvingiagabonensis*	5.34
41	*Rauvolfiavolmitoria*	10.66
42	*Milicia excels*	2.66
43	*Antoclestrialvulgelii*	2.93
44	*Artocarpus heterophyllus*	2.75
45	*Brackystigiaeurycoma*	13.24
46	*Antoclestrialvulgelii*	1.84
47	*Muasngacecropioides*	4.74
48	*Crypsophyllumalbidium*	1.15
49	*Khaya ivorensis*	0.62
50	*Rauvolfiavolmitoria*	4.62
51	*Antoclestrialvulgelii*	1.30
52	*Musangacecropioides*	1.99
53	*Dicryioides edulis*	2.69

54	*Lophiraalata*	0.09
55	*Khaya ivorensis*	15.40
56	*Brackystigiaeurycoma*	4.03
57	*Dicryioides edulis*	2.44
58	*Gmelina arborea*	4.93
59	*Lophiraalata*	0.22
60	*Crypsophyllumalbidium*	9.04
61	*Rauvolfiavolmitoria*	5.97
62	*Dicryioides edulis*	3.21
63	*Musangacecropioides*	1.69
64	*Dicryioides edulis*	0.13
65	*Antoclestrialvulgelii*	2.41
66	*Artocarpus heterophyllus*	18.95
Total	**Number of trees 66**	**603.49**

Discussion

Managing tropical commercially valued rainforest trees in the cocoa plantation has never been the vision of the cocoa farmer. But the importance of forest trees are seen in their unique contribution both to the stability of the environment and to the social values of the people especially the rural areas. The forest trees provide the most suitable environment for the cultivation of cocoa and the mystery of its economy. The forest trees protect the watersheds and soils, provide habitat for numerous species of flora and fauna and generally maintain the biological diversity. In many cases, when the land is cleared for cocoa farming, trees valued for timbers or f00d are left standing. Also some trees are conserved for Trees are shade and soil fertility improvement. Data obtained in this study indicate that some rainforest trees are being conserved in the cocoa plantations. it was found that some forest trees are still existing in the cocoa plantation without facing the increasingly threat of felling of trees for timbers, thereby going extinct. It is also observed that though the trees are existing in the cocoa plantation, although some are gradual exploited by the cocoa plantation owners for the provision of building materials. Some of the trees suffer from old age, and other from the bigger branches of rainforest trees falling on them. Other trees suffer the reduction of basal area due to competition for nutrient and degradation of soil fertility. . It is known that very few rainforest tree species have been successfully established in cocoa plantations in the tropical rainforest region of the world (Akinsanmi and Akindele, 2002). Basal area has been regarded as a better assessor of tree stand growth. In order to engender a sustained yield management of forest trees, availabilities and growth of commercially valued rainforest trees should be ascertained in protected areas including cocoa plantation. Nevertheless, the protections of rainforest trees in cocoa plantation are conservation strategy for the trees outside the natural forest. There is no

doubt that with more effective protection against deforestation, destruction of forest trees and illegal exploitation, the trees would survive and be abundant for future sustainable harvesting. In recent times, efforts are being geared towards conserving forest trees species to prevent further loss of their genetic resources. This is the reason traditional agro forest practice in the form of cocoa farming has been found to be a way of protecting and conserving most of the threatened tree species outside the natural forest. This is done by allowing the forest trees grow alongside with cocoa trees in the cocoa plantation as depicted by the Tree Ring Cultivation Technique (Fig 1.TRC, Offiong, 2006).

Conclusion

Though the economic importance of cocoa trees had over the years been widely and highly emphasized for human consumption all over the world, the aspect of cocoa plantation as a refuge area (buffer) for forest tree conservation is under emphasized. Many valuable rainforest trees species with standard sizes and lengths were found in the cocoa plantations studied. It is recommended that rainforest trees should be properly conserved for sustainable utilization in the future.

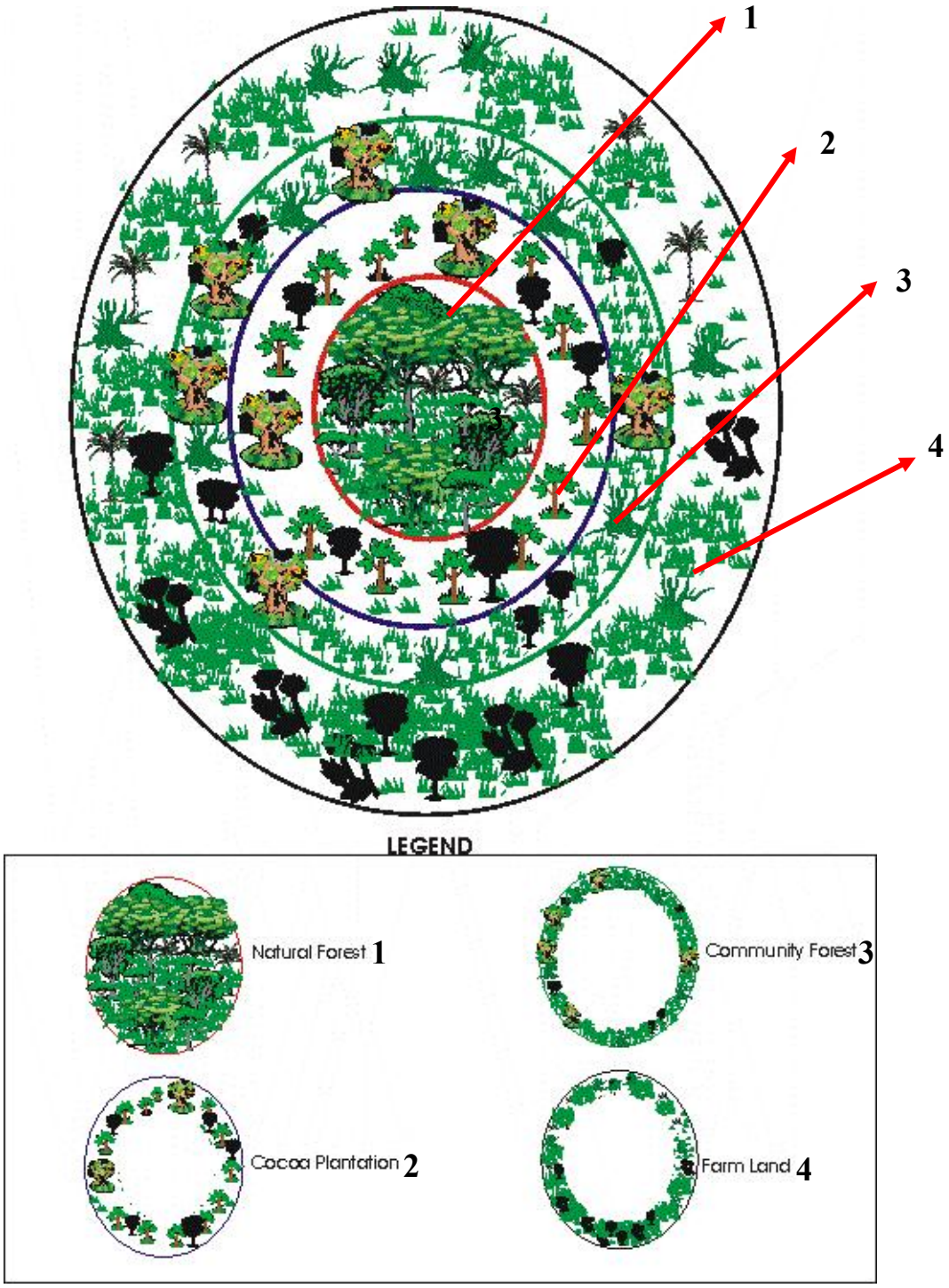

Fig 1: TREE RING CULTIVATION MODEL (Offiong, 2006)

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