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Agroforestry Practices and Woody Species Diversity in Host Communities of Okomu National Park, Edo State, Nigeria

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Abstract: Agroforestry is a sustainable land use alternative for conserving trees outside forests. The agroforestry practices and diversity of woody species in the host communities of Okomu National Park (ONP), Edo State was investigated. The study involved the selection of four communities (10% of 42 communities) based on proximity to the national park boundary and extent of agroforestry. The predominant farming practices engaged in by the farmers were identified and three major ones were selected for the woody species inventory. Three farms of the predominant farming systems identified were randomly selected from each community and used as sample plots, amounting to a total of 12 plots (farms). Each of the farms selected was assessed for farm size, types of trees/shrubs, agroforestry methods. The agroforestry practices by the farmers were assessed by visual observation of the diversity, arrangement of woody species. Total enumeration and identification of all live woody species on each farm was conducted and classified into families and some diversity indicators employed to analyze species diversity. The results revealed that all four communities surveyed were actively involved in traditional agroforestry: scattered farm tree system, tree crop farming under shade of trees, home gardens and boundary tree planting systems. The highest density of woody species recorded in Mile 3 community (517 trees/shrubs H^{-1}) and Mahokhioba community recorded the least value of 134 trees/shrubs H^{-1}. Moraceae and Euphorbiaceae were the most dominant families recorded in the study while Iguowan had the highest Shannon index (*H*) of 2.99. The high population of *Eleais guineensis*, *Cola acuminata*, *Gmelina arborea* and a host of others implies that the farmers deliberately cultivated and retained the species for their economic values thereby ensuring the species sustainability. This strategy can be explored for conserving trees in areas outside protected forests.

Keywords: Woody species; Communities; Agroforestry; Farms; Protected area.

INTRODUCTION

Several schools of thought have attempted to define agroforestry over the years with the different definitions capturing agroforestry as a system of land use where trees are present in agricultural landscape. Agroforestry, according to ICRAF (1997), is a land management system that effectively integrates trees on farms or agricultural lands on a sustainable basis so as to provide economic, environmental and social benefits for all stake holders. It can be described as a sustainably-managed land unit to derive social, economic, and environmental benefits (Sanchez, 1995). Agroforestry systems can be more beneficial than the prevailing agricultural systems and methods of plantation establishment through maximized land use resulting in increased economic and social benefits, as well as provision of ecological goods and services. (Umrani and Jain, 2010). Agroforestry is an effective land use that provides an option for cultivating trees in other land uses besides forest ecosystems (Kohli, 2008).

Furthermore, the goal of most agroforestry systems is to improve on the productivity of farming systems; minimize the production costs of agriculture; create diversity in the utilization of the trees or other woody perennials for products such as food and spices, fodder, fuel wood, lumber

and construction materials. Agroforestry practices may also create opportunities for small-scale forest-based ventures (FAO, 2015). Leakey (1998), explained that Agroforests are a resource with a possibility for sustainability; a worthy compromise between tropical forest biodiversity conservation and beneficial utilization of natural resources. Umrani and Jain (2010) opined that biodiversity in agroforestry landscapes is generally higher than in the conventional agricultural systems. Agroforestry systems is an in-situ conservation land use for a number of species that farmers value and intend to conserve (Dawson *et al*., 2013). It becomes imperative to study the agroforestry practices around protected areas and the abundance and diversity of woody plants available in such systems.

MATERIALS AND METHODS

Study Area

Okomu National Park, which was initially established as Okomu Wildlife Sanctuary, is a forest block within Okomu Forest Reserve (latitudes 6ºN and 6º10'N, and longitudes 5ºE and 5º30'E). A number of rural communities surround the Park which consists of about 42 communities, some of which form boundary with the national park. These include Iguuowan, Maokhioba, Anah Camp, Tunde Camp, Nikorowa, Mile 3 camp. Others are Udoh, Aghobahi, Irezen etc. These surrounding communities farm within and around the forest reserve. Anah Camp and Mahokhioba enclaves occupy a farm area within the park regarded as Reuben Excision. The fringe communities are majorly involved in arable (tubers, suckers, vegetables) and cash (oil palm, cocoa and kola) crop farming. Other sources of livelihood include lumbering, hunting and trading.

Vegetation of the area has been described by White (1979 cited by Isikhuemen and Ikponmwoba, 2020) as a tropical lowland rain forest, which also included areas of swamp-forest, high, secondary and open scrub forest type; which supports a distinctive biodiversity combination. The forest comprises rainforest, fringing/riparian, freshwater and lacustrine ecosystems Tree species such as *Antiaris africana, Alstonia congoensis, Triplochiton scleroxylon* are commonly found in the park. Soils are acidic, nutrient poor sandy loam.

Sampling Procedure

A reconnaissance survey was conducted in the Okomu national park and the adjoining communities to locate the boundaries of the selected sites and get acquainted with the general conditions of the study area and determine the predominant farming systems. Four communities (10% sampling intensity) were selected from the 42 communities around the national park. The four communities were selected purposively based on nearness to the national park boundary.

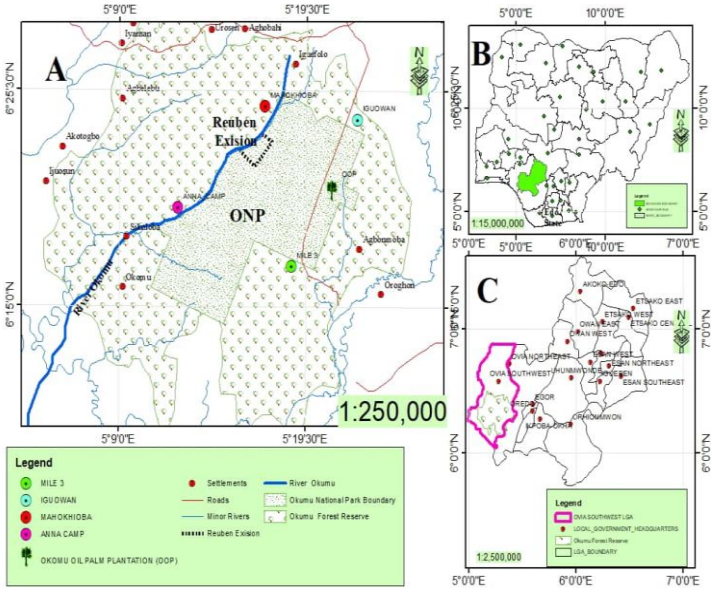

Figure 1. Okomu Forest Reserve showing National Park and study sites.

The predominant farming the farmers were involved in were identified from the reconnaissance survey, and the three major ones were selected for the woody species inventory. Three (3) farms were randomly selected from each community according to the predominant farming practice. These were used as sample plots, which amounted to a total of 12 plots (farms) for the study. The coordinates of the sample locations were collected accordingly using a GPS (Figure 2).

Method of Data Collection

Each of the sample farms selected was assessed for the size of farm, types of trees/shrubs. Total enumeration of all live woody species on each farm was carried out, and the number and diversity of the trees/shrubs was recorded. The agroforestry methods practiced by the farmers were assessed by visual observation of the diversity, arrangement and types of woody species present on each farm.

Tree Species Identification

The woody perennials encountered during the field survey was identified and enumerated with the assistance of an expert field taxonomist. Books such as Nigerian Trees (Kaey, 1989) was consulted for species that were identified in their local names.

Diversity indices and classification of trees and shrubs

All woody species identified were classified into families. Woody species diversity was analyzed using various diversity indicators. Shannon diversity index (H^1), Shannon equitability/evenness index (E), and Margalef's species richness index were computed and analyzed. These diversity indices provided essential data about the commonness and rareness of species present in a community.

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Shannon-Wiener Diversity Index (H^1):

Shannon's indicator accounts for both richness and evenness of the available species. The indicator presumes that all the species are present in the sample with its value lying between 1.5 and 3.5. However, 4.5 have been recorded in exceptional cases. (Magurran, 1988).

$$H = -\sum_{i=1}^{s} p_i \ln p_i \quad \ldots\ldots (1)$$

Where *s* is the total sum of species; p_i is the proportion of individualities in the ith species, and *ln* is the natural logarithm.

Species Evenness Index (*E*):

Evenness expresses how the individualities of a population are evenly distributed among a variety of species. Evenness assumes a value between 0 and 1, with 1 expressing complete evenness. Pielou Evenness Index (Pielou, 1969) is computed as:$= \frac{H}{\ln S}$; where *H* is the Shannon–Wiener function and *S* is the sum of species, *ln* is natural logarithm.

Margalef Index (*MI*):

Margalef index, which is a measure of the number of a variety of species represented in the forest ecosystem (species richness), was computed as (Margalef, 1988):

$$MI = \frac{S-1}{\ln N}$$

Where *S* is the total number of species and N is the number of individuals.

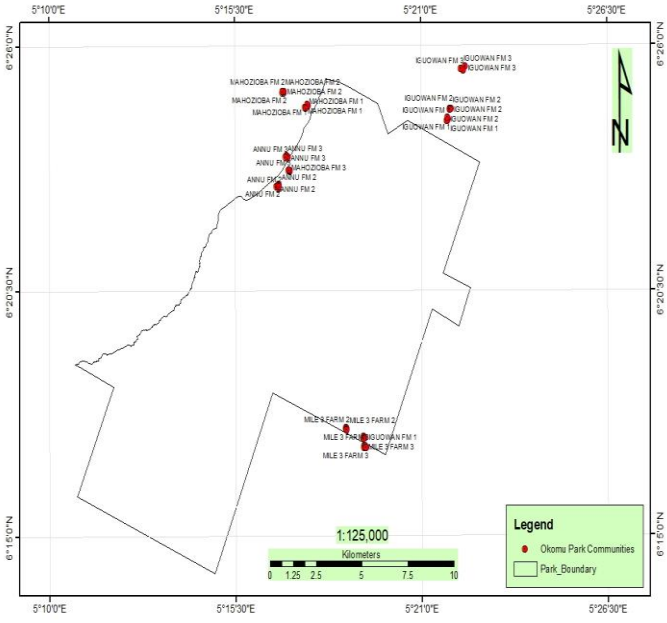

Figure 2. Map of ONP showing agroforestry sample plots for biodiversity study

RESULTS AND DISCUSSION

Agroforestry Systems Practiced in the Host Communities Surveyed

The farming systems identified in the fringe communities of Okomu National Park, sizes of farms and the agroforestry systems practiced by the communities is presented in Table 1. Iguowan, Mile 3, Mahokhioba and Anna Camp are the major communities which border the national park from the northern, southern and western sections (Figure 2) respectively. The field observations revealed that the people were basically farmers who engaged in different arable and cash crops production. Each of the three sample farms (per community) surveyed was composed of arable crop and tree/shrub components. Nevertheless, three predominant farming systems were identified in the study area: Cassava (*Manihot esculenta* Crantz), Cocoa (*Theobroma cacao* L.) and Plantain (*Musa paradisca*) cropping systems. All four communities surveyed were actively involved in traditional agroforestry practices which were identified according to the arrangement of the elements of the system. These agroforestry practices were scattered farm tree system, tree crop farming under shade of trees, home gardens and boundary tree planting systems. The Iguowan farms surveyed were characterized by the scattered farm tree system and the home gardens, and the predominant cropping system identified was Plantain, followed by Cassava. Cocoa was the major cultivated crop identified in Mile 3 and Anna Camp in a typical tree-crop-farming-under-shade agroforestry. Also, Mahokhioba farms were characterized by boundary planting method of agroforestry, with Cassava as the predominant crop. Other arable crops cultivated in the farming systems include tubers such as yams, suckers like banana, vegetables and pineapples.

The field observations revealed that the components of the farming systems were basically arranged in a mixed polyculture typical of traditional agroforestry system. The woody components in three Cassava agroforestry farms were particularly retained or planted mostly at the boundaries, indicating the farmers preferred retaining tree components at the boundaries of their farms, surrounding the cassava crops. Furthermore, the researcher observed a number of tree-burning and felling within some cassava farms, which further suggests that most of the farmers of cassava crops do not inter-plant trees with the crops. It can be inferred that the farmers may have observed low yield of cassava resulting from interplanting cassava and tree species, hence, do not plant trees or completely eliminate existing trees which are within the farm. In an experiment carried out at Attotinga in Benin Republic, Lose *et al.* (2003) observed that the woody perennials repressed the root system of cassava rows close by in a soil depth of about 0–0.2m, which resulted to severe competition in the cassava rows besides the block. The author further explained that an excess spread of the transverse tree roots in the topsoil layer, could result in competing with the arable crops for water and nutrient elements.

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Cocoa agroforestry was mixed woodland of multipurpose tree species, ranging from timber trees, fruit trees and other trees of high economic value, with an understory of a few arable crops. The farms were traditional cocoa agroforests, with the components in a random polyculture depicting scattered farm tree system or a woodland of multipurpose species of different canopy trees. According to Duguma *et al.* (2001), the utilization of several species within an agroforestry land use provides distinct structural and integrated heterogeneity. Cultivation of shade crops such as cocoa and coffee under the canopy of native tree species, in some tropical regions, gives the plantation a semblance to the structure of neighboring forests (Bhagwat *et al*., 2008). In addition, the undergrowth of food crops and upper-story of trees established on cocoa farms have been reported to be useful for food, additional income, risk minimization through variety of products, and provision of shade for cocoa plants (Duguma *et al*., 2001; Isaac *et al*., 2007 and Oke and Odebiyi, 2007).

According to IITA (2009), Plantain is an essential food and cash crop which is highly significant in the rural and urban economy, as well as the social and cultural life of sub-Saharan Africa. The plantain farming system was characterized by a mix of different woody species, indicating that the farmers deliberately retained various tree species on the plantain farms possibly because the trees did not interfere with the performance of the plantain crops, and also for the economic benefits of the tree species. This polyculture structure of the plantain agroforestry implies that plantain can be successfully cultivated in a scattered farm tree or home garden. Furthermore, some species of *T. cacao* were identified in most of the plantain farms surveyed. Plantain has been reported to serve as an excellent shade for *T. cacao* (Asare, 2005; Isaac and Dowoe, 2009; Orisajo *et al*., 2016).

Woody Species Diversity in the Agroforestry Land uses Surveyed

The abundance and diversity of the trees and shrubs surveyed in Mile 3 land use is revealed in Table 2. A total population of 517 individual tree species (ha^{-1}) belonging to 39 species and 24 families were surveyed at the Mile 3 farms that were visited. Moraceae, Mimosoideae were the richest families each having 4 species; followed by family Apocynaceae which has three species. The predominant species were *Eleais guineensis, Gmelina arborea, and Macaranga barteri*, which amounted to 108, 68 and 45 individuals (ha^{-1}) respectively.

The Shannon's diversity index of Mile 3 was 2.96; Species evenness was 0.47 and Margalef index had a value of 6.24. The density and diversity of trees and shrubs in Iguowan community of ONP is presented below (Table 3). A total population of 153 individual trees and shrubs belonging to 30 species and 17 families (ha^{-1}) were encountered in the three Iguowan farms surveyed. The richest families were Euphorbiaceae and Rubiaceae, each having four species while Apocynaceae had 3 species. The predominant families were *Albizia zygia, Albizia adianthifolia and Dacryodes edulis barteri* (30, 13 and 10 individuals ha^{-1} respectively). The Shannon's diversity index of Iguowan was 2.99; Species evenness was 0.59 and Margalef index was 5.96.

Table 1. Agroforestry, Farm sizes of Farming Systems of Sampled Communities.

Farm Location	Sample Plots	Predominant Farming System	Farm size (H^{-1})	Agroforestry practice
Iguowan	Farm 1	Cassava	187m x 178m	Scattered farm tree
	Farm 2	Plantain	120 x 35m	Scattered farm tree
	Farm 3	Plantain	68m x 30m	Home garden
Mile 3	Farm 1	Cocoa	50m x 63m	Tree-crop farming under shade trees
	Farm 2	Cocoa	70m x 47m	Tree-crop farming under shade trees
	Farm 3	Plantain	80m x 57m	Scattered farm tree
Mahokhioba	Farm 1	Cassava	140m x 65m	Boundary tree planting
	Farm 2	Cassava	85m x 52m	Boundary tree planting
	Farm 3	Plantain	140 mx 50m	Boundary tree planting
Anna Camp	Farm 1	Cassava	117 mx 79m	Boundary tree planting
	Farm 2	Cocoa	40m x 64m	Tree-crop farming under shade trees
	Farm 3	Cocoa	155m x 106m	Tree-crop farming under shade trees

The results obtained from Mahokhioba farms (Table 4) community of OFR revealed that a total population of 134 individual trees and shrubs belonging to 29 species and 17 families (ha^{-1}) were encountered in the three Mahokhioba farms surveyed. Families Moraceae, Mimosoideae and Euphorbiaceae were the richest families having four families each. The predominant species were *Distremonanthus benthamianus, Alstonia boonei* and *Eleais guineensis* (24, 16, 15 individuals ha^{-1} respectively). The Shannon's diversity index of ONP was 2.85, Species evenness was 0.58 while Margalef index was 5.72.

The density and diversity of the trees and shrubs surveyed in the Agroforestry farms of Anna Camp, shown in Table 5, revealed that a total population of 392 individual trees (ha^{-1}) belonging to 32 species and 19 families were surveyed at the Anna Camp farms that were visited. Family Moraceae was the richest with 5 species

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while families Annonaceae and Caesalpinioideae both had 3 species each. *Cola acuminata* was the predominant species (117 individuals ha^{-1}), followed by *Eleais guineensis* which had 99 individuals ha^{-1}. The Shannon's diversity index of Anna Camp was 2.36, Species evenness was 0.39, while the Margalef index value was 5.19.

Table 2. Woody Species Diversity in the Agroforestry Farms of Mile 3.

S/N	Species	Family	Frequency	Density (Trees/Ha)
1	*Albizia adianthifolia* (Schumach) W. Wight	Mimosoideae	1	2
2	Albizia zygia (DC.) J.F.Macbr.	Mimosoideae	1	2
3	*Allanblackia floribunda* Oliv.	Guttiferae	2	6
4	*Alstonia boonei* De Wild	Apocynaceae	12	34
5	*Amphimas pterocarpoides* Harms	Papilionoideae	2	4
6	*Anthocleista vogelii* Planch.	Longaniaceae	1	2
7	*Blighia sapida* K. D. Koenig	Sapindaceae	1	2
8	*Bombax buonopozense* P.Beauv.	Bombacaceae	2	5
9	*Brenania brieyi* (De Wild.)	Rubiaceae	2	4
10	*Ceiba pentandra* (L.) Gaertn.	Bombacaceae	2	5
11	*Cleistopholis patens* (Benth) Engl. & Diels	Annonaceae	5	11
12	*Diospyros dendo* Welw. ex Hiern	Ebenaceae	1	2
13	*Diospyros suaveolens* Gürke	Ebenaceae	4	9
14	*Distemonanthus benthamianus* Biall.	Caesalpinioideae	2	4
15	*Eleais guineensis* Jacquin.	Palmae	37	108
16	*Eribroma oblanga* (Mast.) Pierre ex A.Chev.	Streculiaceae	5	12
17	*Ficus exasperata* (Vahl).	Moraceae	1	2
18	*Funtumia elastica* (Precess) Stapf	Apocynaceae	3	9
19	*Gmelina arborea* Roxb. ex Sm	Lamiaceae	22	68
20	*Harungana madagascariensis* Lam.	Guttiferae	1	3
21	*Irvingia wombulu* Vermoesen	Irvingiaceae	3	8
22	*Macaranga barteri* Müll.Arg.	Euphorbiaceae	18	45
23	*Melicia excelsa* Welw. C.C. Berg	Moraceae	1	2
24	*Musanga cecropoides* R. Br.	Moraceae	17	50
25	*Myrianthus arboreus* P.Beauv.	Moraceae	1	3
26	*Pentaclethra macrophylla* Benth.	Mimosoideae	2	6
27	*Piptadeniastrum africanum* (Hook.f.) Brenan	Mimosoideae	4	13
28	*Psydrax arnoldiana* (De Wild. & Th. Dur.)	Rubiaceae	4	10
29	*Pycnanthus angolensis* (Welw.) Warb.	Myristicaceae	2	6
30	*Rauvolfia vomitoria* Afzel	Apocynaceae	4	11
31	*Ricinodendron heudolotii* (Baill.)	Euphorbiaceae	2	6
32	*Spathodea campanulata* P.Beauv.	Bignoniaceae	1	3
33	*Strombosia pustulata* Oliv.	Olacaceae	2	5
34	*Tectona grandis* L. f.	Lamiaceae	11	32
35	*Terminalia ivorensis* A. Chev	Combretaceae	1	3
36	*Terminalia superba* Engl. & Diels	Combretaceae	1	3
37	*Theobroma cacao* L.	Malvaceae	4	9
38	*Trema guineensis* (Schumach.& Thonn.)	Ulmaceae	1	3
39	*Zanthoxylum zanthoxyloides* (Linn.)	Rutaceae	1	2
		Total		**517**

Table 3. Woody Species Diversity in the Agroforestry Farms of Iguowan

S/N	Species	Family	Frequency	Density (Trees/Ha)
1	*Albizia adianthifolia* (Schumach) W. Wight	Mimosoideae	7	13
2	*Albizia zygia* (DC.) J.F.Macbr.	Mimosoideae	7	30
3	*Allanblackia floribunda* Oliv.	Guttiferae	1	2
4	*Alstonia boonei* De Wild	Apocynaceae	2	7
5	*Amphimas pterocarpoides* Harms	Papilionoideae	2	3
6	Baphia nitida Lodd.	Papilionoideae	1	2
7	Brenania brieyi (De Wild.) Petit	Rubiaceae	1	2
8	*Dacryodes edulis* (G.Don) H.J.Lam.	Burseraceae	2	10
9	*Drypetes chevalieri* Beille ex Hutch. & Dalziel	Euphorbiaceae	1	2
10	*Eleais guineensis* Jacquin.	Palmae	4	1

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11	*Entandrophragma utile* (Dawe & Sprague)	Meliaceae	1	2
12	*Ficus camptoneura* Mildbr.	Moraceae	1	2
13	*Funtumia elastica* (Precess) Stapf	Apocynaceae	1	2
14	*Humalium letestui* Pellegr.	Flacourticeae	1	2
15	*Jatropha curcas* L.	Euphorbiaceae	2	10
16	*Maesobotrya barteri* (Baill.) Hutch.	Euphorbiaceae	1	0
17	*Morinda lucida* Benth.	Rubiaceae	1	2
18	*Musanga cecropoides* R. Br.	Moraceae	1	2
19	*Newbouldia laevis* P. Beauv.	Bignoniaceae	1	5
20	*Pentaclethra macrophylla* Benth.	Mimosoideae	2	3
21	*Psydrax arnoldiana* (De Wild. & Th. Dur.)	Rubiaceae	1	5
22	*Psydrax arnoldiana* (De Wild. & Th. Dur.)	Rubiaceae	1	2
23	*Pycnathus angolensis* (Welw.) Warb.	Myristicaceae	2	10
24	*Rauvolfia vomitoria* Afzel	Apocynaceae	1	1
25	*Ricinodendron heudolotii* (Baill.)	Euphorbiaceae	2	6
26	*Spondia mombin* Linn	Anacardiaceae	4	1
27	*Tectona grandis* L. f.	Lamiaceae	1	5
28	*Terminalia superba* Engl. & Diels	Combretaceae	4	10
29	*Trema guineensis* (Schumach.& Thonn.)	Ulmaceae	1	5
30	*Trichilia monadelpha* (Thonn) JJ De Wilde	Meliaceae	1	2
		Total		**153**

Table 4. Woody Species Diversity in the Agroforestry Farms of Mahokhioba

S/N	Species	Family	Frequency	Density (Trees/Ha)
1	*Albizia zygia* (DC.) J.F.Macbr.	Mimosoideae	1	1
2	*Albizia adianthifolia* (Schumach) W. Wight	Mimosoideae	11	12
3	*Alchornea cordifolia* (Shum & Thon.)	Euphorbiaceae	1	1
4	*Alstonia boonei* De Wild	Apocynaceae	10	16
5	*Amphimas pterocarpoides* Harms	Papilionoideae	2	2
6	*Antiaris africana* Engl.	Moraceae	2	2
7	*Baphia nitida* Lodd.	Papilionoideae	1	1
8	*Bombax buonopozense* P.Beauv.	Bombacaceae	3	3
9	*Canarium schweinfurthii* Engl.	Burseraceae	1	1
10	*Cleistopholis patens* (Benth) Engl. & Diels	Annonaceae	2	3
11	*Distemonanthus benthamianus* Biall.	Caesalpinioideae	22	24
12	*Eleais guineensis* Jacquin.	Palmae	11	15
13	*Entandrophragma cylindricum* (Sprauge)	Meliaceae	1	2
14	*Eribroma oblanga* (Mast.) Pierre ex A.Chev.	Streculiaceae	4	4
15	*Ficus exasperata* (Vahl).	Moraceae	1	1
16	*Hevea brasiliensis* (Willd. ex A. Juss.)	Euphorbiaceae	7	10
17	*Irvingia wombulu* Vermoesen	Irvingiaceae	1	1
18	*Khaya ivorensis* A Chev.	Meliaceae	1	1
19	*Macaranga barteri* Müll.Arg.	Euphorbiaceae	3	3
20	*Musanga cecropoides* R. Br.	Moraceae	1	2
21	*Myrianthus arboreus* P.Beauv.	Moraceae	1	1
22	*Napoleonae vogelii* (Shrub) Planch.	Lecythidaceae	5	5
23	*Nauclea diderrichii* (De Wild. & Th.Dur.)	Rubiaceae	1	2
24	*Pentaclethra macrophylla* Benth.	Mimosoideae	3	4
25	*Piptadeniastrum africanum* (Hook.f.) Brenan	Mimosoideae	3	3
26	*Pycnathus angolensis* (Welw.) Warb.	Myristicaceae	5	5
27	*Rauvolfia vomitoria* Afzel	Apocynaceae	2	2
28	*Ricinodendron heudolotii* (Baill.)	Euphorbiaceae	1	1
29	*Trema guineensis* (Schumach.& Thonn.)	Ulmaceae	1	1
		Total		**134**

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Table 5. Woody Species Diversity in the Agroforestry Farms of Anna Camp

S/N	Species	Family	Frequency	Density (Trees/Ha)
1	*Albizia adianthifolia* (Schumach) W. Wight	Mimosoideae	1	4
2	*Alstonia boonei* De Wild	Apocynaceae	7	10
3	*Amphimas pterocarpoides* Harms	Papilionoideae	6	18
4	*Anthonotha macrophylla* P Beauv.	Caesalpinioideae	3	12
5	*Blaghia sapida* K. D. Koenig	Sapindaceae	1	4
6	*Bombax buonopozense* P.Beauv.	Bombacaceae	1	1
7	*Buchholzia coriaceae* Engl.	Capparidaceae	1	4
8	*Cleistopholis patens* (Benth) Engl. & Diels	Annonaceae	1	1
9	*Cola acuminata* (P.Beauv.) Schott & Endl.	Streculiaceae	30	117
10	*Cola nitida* (Ventenat) Schott & Endlicher.	Streculiaceae	11	13
11	*Distemonanthus benthamianus* Biall.	Caesalpinioideae	1	1
12	*Eleais guineensis* Jacquin.	Palmae	58	99
13	*Entandrophragma angolense* (Welw.) C DC	Meliaceae	1	4
14	*Eribroma oblanga* (Mast.) Pierre ex A.Chev.	Streculiaceae	9	35
15	*Ficus camptoneura* Mildbr.	Moraceae	2	8
16	*Ficus exasperata* (Vahl).	Moraceae	16	13
17	*Ficus mucuso* Welw. ex Ficalho	Moraceae	1	4
18	*Ficus sur* Forssk.	Moraceae	1	1
19	*Funtumia elastica* (Precess) Stapf	Apocynaceae	1	4
20	*Hylodendron gabunense* Taub.	Caesalpinioideae	1	4
21	*Irvingia wombulu* Vermoesen	Irvingiaceae	2	1
22	*Lannea welwitschii* (Hiern) Engl.	Anacardiaceae	1	4
23	*Leucaena leucocephala* (Lam.) de. Wit)	Fabaceae	2	2
24	*Morinda lucida* Benth.	Rubiaceae	1	1
25	*Musanga cecropoides* R. Br.	Moraceae	1	1
26	*Pentaclethra macrophylla* Benth.	Mimosoideae	1	1
27	*Pycnanthus angolensis* (Welw.) Warb.	Myristicaceae	3	10
28	*Ricinodendron heudolotii* (Baill.)	Euphorbiaceae	1	4
29	*Strombosia pustulata* Oliv.	Olacaceae	2	8
30	*Terminalia ivorensis* A. Chev	Combretaceae	1	1
31	*Terminalia superba* Engl. & Diels	Combretaceae	1	4
32	*Trichilia monadelpha* (Thonn) JJ De Wilde	Meliaceae	1	1
		Total		**392**

Table 6. Summary of Tree Species Abundance and Diversity Indices of Mile 3, Iguowan, Mahokhioba and Anna Camp

Land Use	No of Species	No of Families	Density of Trees Ha^{-1}	Shannon _H′	Evenness _e^H/S	Margalef (*MI*)
MILE 3	39	24	517	2.96	0.47	6.24
IGUOWAN	30	17	153	2.99	0.59	5.96
MAHOKHIOBA	29	17	134	2.85	0.58	5.72
ANNA CAMP	32	19	392	2.35	0.40	5.19

The results of the woody species inventory revealed a typical agroforestry system which was a diversity of timber trees, fruit trees, leguminous trees and shrubs, including food crops. The population of woody species indicates that traditional farming systems contribute to the conservation of a population of trees and shrubs. Agroforestry land uses are in situ conservation areas for a diversity of woody perennials that farmers value and may wish to conserve (Dawson *et al*., 2013). Each of the agroforestry plot visited was characterized by a haphazard polyculture of woody species, giving the farming systems a semblance of natural forests (Leakey, 1998). All the communities visited had a population of different species of trees, with the highest density recorded in Mile 3 farms (517 Ha^{-1}) and the least population was recorded in Mahokhioba farms (134 Ha^{-1}). The density and diversity of woody species in farming systems can be influenced by choice of farmers and usefulness to the species to the farmers (Osadolor *et al*., 2020). Moraceae was a dominant family common to Mile 3, Anna Camp and Mahokhioba farms, Euphorbiaceae was the dominant family common to Mahokhioba and Iguowan agroforestry. *Eleais guineensis* had a high population density in Mile 3, Anna Camp and Mahokhioba farms respectively. Despite the high density of the trees/shrubs recorded in Mile 3 farms, *E. guineensis* (108 individuals Ha^{-1}) was the most dominant species, which was followed

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by *Gmelina arborea* and *Macaranga bateri* (68 and 50 individuals H^{-1} respectively).

The different diversity indices analyzed (Table 6) revealed that despite the abundance of woody species in the community farms inventoried, the low value of species evenness was an indication that population of individual species was not evenly distributed. According to the Pielou's evenness index (1969), a value for evenness approaching 0 reflects large differences in abundance of species, while an evenness of 1 means all species are equally abundant. Also, the high population of *Eleais guineensis, Cola acuminata, Gmelina arborea, Albizia species, Dacryodes edulis* implies that the farmers deliberately cultivated the species for their economic values. Nevertheless, the farmers of the four communities surveyed engaged in traditional agroforestry practices in which the famers willingly retained and cultivated trees and shrubs without being compelled. Improving on this form of crop and woody perennial land use can reduce pressure on protected forests (Vodouhe *et al*., 2011). It becomes imperative to encourage and develop these farming systems as a strategy for woody species conservation outside protected forests of tropical ecosystems.

CONCLUSION

The four communities surveyed were actively involved in agroforestry practices. The density and diversity of the species clearly describes a typical mixed polyculture traditional farming system. Also, some of the farms surveyed (particularly the cocoa and plantain farming systems) were woodlots of indigenous and exotic species. The combination of tree species was an indication that most of the species were cultivated by the farmers. Traditional agroforestry practices, as revealed by this study, supports and conserves a diversity of important woody species.

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Conflict of Interest

There are no conflicts of interest declared by the authors.

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