Olanya, J Ecosys Ecograp 2020, 10:1

Journal of Ecosystem and Ecography

Research Open Access

Diversity, Population Structure and Regeneration Status of Indigenous Woody Species in and Around Agoro-Agu Central Forest Reserve, Uganda

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Received: April 15, 2020; **Accepted:** April 28, 2020; **Published:** May 04, 2020

Abstract

Wooded ecosystems provide a range of goods and services to humankind especially to local rural communities in particular. The extraction of these resources raises concerns in relation to the ecological impacts on biodiversity and ecosystem processes. This study assessed the diversity, population structure and regeneration status of the indigenous woody species in and around the Agoro-Agu Central Forest Reserve. A systematic transect sampling technique was used in the study. A total of 216 quadrats of 20 x 20 m were sampled; 108 in the forest; and the remaining 108 were sampled in the farmlands. The study recorded a total of 93 woody species in 62 genera and 31 families both in the Forest Reserve and Farmland. The diversity index (Shannon-Wiener Diversity Index H′) was significantly higher in the farmland (3.2) than in the forest reserve (3.0) (P<0.05). Overall, the farmland had more dense (4,084.03m^2/ha) woody species compared to the forest reserve (3,953.70 m^2/ha). The ecologically most important species in the forest were *Terminalia brownii* (IVI = 50.8) followed by *Combretum molle* (IVI = 50.1). *Terminaliabrownii* and *Acacia hockii* were ecologically more dominant in the farmland with IVIs of 48.3 and 31.7, respectively. The overall population structure of the species encountered in the forest and farmland reflects an inverse J-shape, indicating good and stable regeneration.

Keywords Density; Dominance; Frequency; Importance value index

Introduction

Loss of forest cover and biodiversity due to anthropogenic activities is a growing global concern [1]. Ikyaagba, Jande and Abiem [2] estimate that over 130,000 km^2 of tropical forests are lost yearly. This is roughly 50 football fields in a minute [3]. This disappearance affects both the community forests and protected areas [4]. Declining vegetation cover is closely associated with drought and food and nutrition insecurity that have become major threats affecting the life of millions of people [5]. In Uganda, Central Forest Reserves were established to provide forest products, amenity and recreation, conserve biodiversity, ameliorate climate, stabilize soils, and protect water catchments and steep slopes, river banks, and lake shores [6]. Like many Protected Areas, Agoro-Agu Central Forest Reserve (CFR) is exploited for various forest products and services such as fuelwood, timber, building poles, medicines and food [7]. The extraction of these resources may affect the forest structure and species diversity through fragmentation, habitat loss and degradation. Woody plant species form a major structural and functional basis of tropical forest ecosystems (Kumar Marcot and Saxena, 2006). Increasing anthropogenic pressure on forest ecosystems has altered their structure and functioning [8]. The type of population structure displayed by woody plants reflects the conservation status of the forest (Nabasumba, Eilu, Bahati and Katwesigye, 2016). Woody plant species display four patterns of population structure, including interrupted inverse J shape, J shape, Bell shape and Irregular pattern [9]. This study assessed the diversity, population structure and regeneration status of the indigenous woody species in and around the Agoro-Agu Central Forest Reserve. The specific objectives of the study were to: i) investigate the species diversity and richness; ii) assess similarities in composition of woody species between the two land use types; iii) determine the density, frequency, dominance and important value indices of woody species in the study sites; and (iv) assess the population structure and regeneration status of the woody species in the study sites. Such assessments are important in documenting the status of the woody species, upon which sound management plans of conservation and sustainable utilization could be based.

Study area and Methods

Study Area

Agoro-Agu Central Forest Reserve (CFR) is located in Lamwo district along the border between Uganda and Southern Sudan, at 03° 40'- 03053′ N and 32042′ - 330 04′ E, and an altitude ranging between 110-2700m above sea level (Davenport and Howard, 1996), as indicated in Figure 1. The Forest Reserve covers a total of 26,508 hectares. It was gazetted in 1937, as a natural forest for biodiversity conservation [8]. The Reserve is covered by a forest / savanna mosaic at high altitudes. Common vegetation types are *Combretum-Acacia-Themeda savanna, Juniperus-Podocarpus*, dry montane forest, *Cyperus-papyrus swamp, Acacia-Cymbopogon-Themeda* complex; and *Butyrospermum-Hyparrheniadissoluta savanna.*

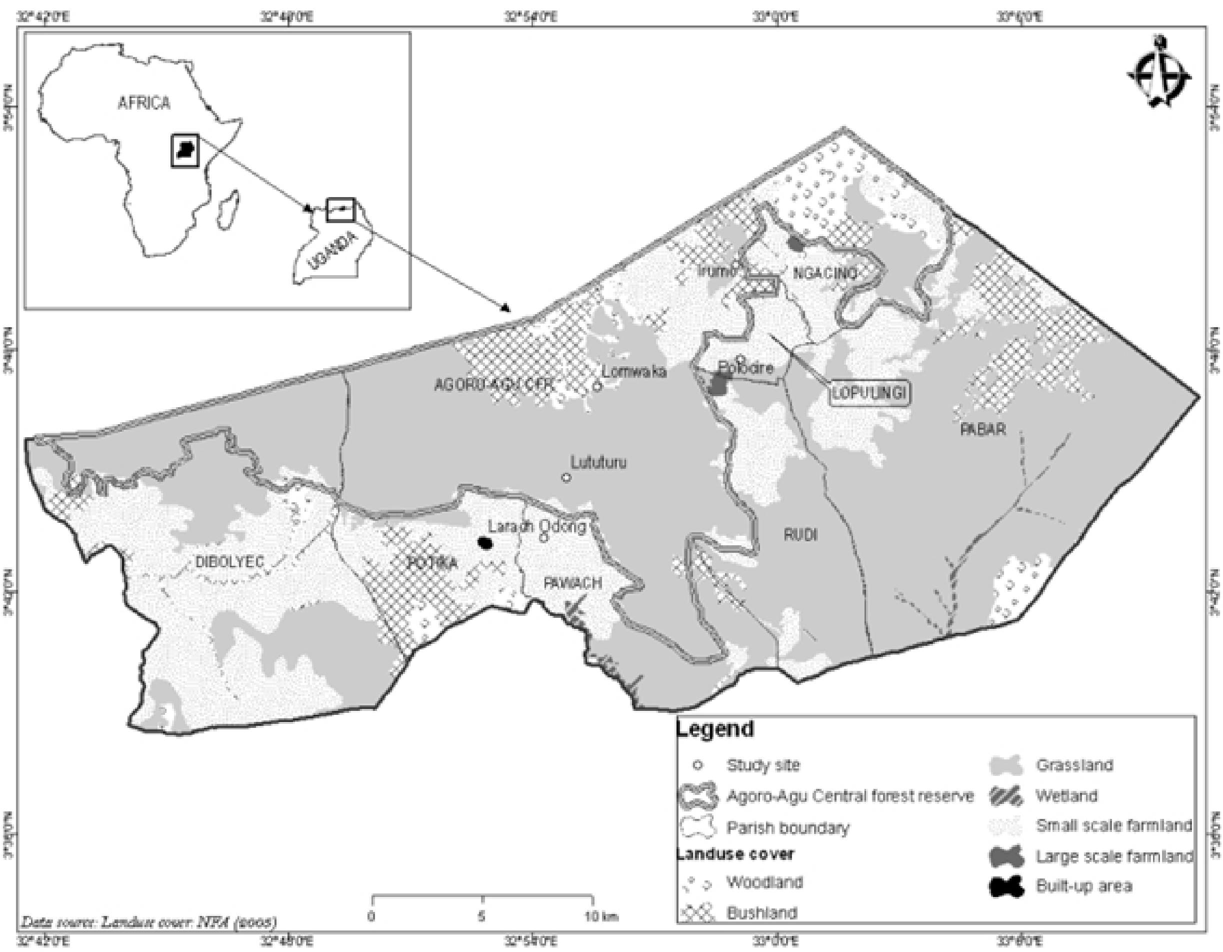

Figure 1: Map of Agoro-Agu showing the study sites

Rainfall is bimodal in Lamwo district. Rain starts in late March or early April and ends in November, with peaks in April and August, ranging from 800 mm – 1000 mm. It is dry-hot and windy from December to mid March. Temperature ranges between 20°C and 30°C. Gray-brown sands overlying red clay or brown sandy loam soils characterize the area.

Methods

Field surveys were conducted in five sites; three from inside the forest reserve and the two from the adjacent farmlands, as indicated in Figure 1. A systematic transect sampling technique was used in the five sites. A total of 216 plots were sampled; 108 in the forest; and the remaining 108 were sampled in the farmlands. At each site, a total of four transect lines facing north-south compass direction were established. The transects were each 1 km long. The first transect was randomly placed, and the subsequent ones placed parallel to the first one at intervals of 300 m. The first quadrat measuring 20 x 20 m on every transect line was randomly placed. Thereafter, each succeeding quadrat was placed alternately every 100 m, and 5 m off the transect line to minimize edge effects. The 20 x 20 m plots were nested into; 10 x 10 m; 10 x 5m; and 5 x 5m. In each of the quadrats, the following were recorded: identity of all woody species, number of live individuals of all the woody species, and measurement of diameter at breast height (DBH), or at 1.3 m of all woody species (with DBH >2 cm), except juveniles (seedlings). In the case of seedlings, the number of individuals of each species was counted and recorded in each quadrat. A calliper and graduated measuring stick were used to measure diameter, respectively, of the woody plants.

Data Analysis

To assess the woody species diversity in and around the forest reserve, the Shannon-Wiener diversity index was used. Its equation is;

$$H' = -\sum Pi * \ln Pi$$

Where H' is the Shannon Diversity index, Pi is the importance value of a species as a proportion of all species [10]. A simple randomization test was conducted to assess whether the observed differences in species diversity were significant [11]. In order to compare the woody species composition between the forest and farmland, analysis of similarity (ANOSIM) was conducted on species abundance data using the Community Analysis software Package (CAP Version 4). This approach uses a permutation-based multivariate simulation to test whether the species composition between any two sites differs significantly. As it was found that the difference in species composition between the forest and the farmland was significant, it was decided to continue with a similarity percentage (SIMPER) analysis as described in Clarke et al [12]. SIMPER analysis determines which species contributed towards the observed differences in species composition between any two sites. Density of woody species was determined by converting the total number of individuals of each woody species encountered in all the quadrats to equivalent number per hectare as described in Mueller-Dombois and El- lenberg [13]. The frequency was calculated as the proportion (%) of the number of quadrats in which each woody species was recorded from the total number of quadrats in each of the sites. Dominance of the woody species was determined from the space occupied by a species, usually its basal area (BA). The mean dominance of each species was computed by converting the total basal area of each woody species to equivalent basal area per hectare [14]. To determine the overall importance of each woody species in the community structure, the importance value indices (IVI) were computed. The IVI is calculated by summing up relative density, relative dominance, and relative frequency of every species [15]. To determine the population structure of the woody species, diameter at breast height (DBH) data were grouped into four size classes: 1 - <5, 5 - <10, 10 – 25, and >25. The shape of the size class distributions shows the future regenerative potential of species [16]. A regenerating population shows a reverse J-shaped plot. For each species, density in each size class was plotted against the size classes using SigmaPlot software version 8.0. For size class distributions, only species with 10 or more individuals encountered in the study plots were selected. The species density data was Log10 (density + 1) transformed in order to achieve a normal distribution and minimize outliers [17]. Based on the profile depicted in the population structures, the regeneration status of each woody species was determined. The status of regeneration of species determined based on the population size of seedlings, saplings and adults [18].

Results and Discussion

Woody Species Diversity

The study recorded a total of 93 woody species in 62 genera and 31 families both in the Forest Reserve and Farmland (Table 1). Among them, 47 species (49.5 %) occurred in the two land use types; 21 species (22.1 %) were encountered in the Forest Reserve alone, while 25 species (26.3 %) were only encountered in the Farmland. *Mimosaceae* and *Moraceae* were the most species-rich families in the study area. Analysis of similarity (ANOSIM) showed a significant difference in species composition between the Forest Reserve and the Farmland (RANOSIM = 1.88, P = 0.001). Similarity percentage (SIMPER) analysis between the two land use types showed that Terminaliabrownii,Combretummolle, and Acacia hockii.contributed the most (13.5 %,11.6 %,10.3 %) to the variation in species composition. On the other hand, Prosopispallida, Acacia macrothyrsa, and Strychnosspinosa had the least (0.4 %, 0.5%, 0.5%, respectively) effect on species dissimilarity. The diversity index (Shannon-Wiener Diversity Index H′) was significantly higher in the farmland (3.2) than in the forest reserve (3.0) (P<0.05).

S.No.	Species	Family	Forest Reserve	Farmland
1	*TerminaliabrowniiFresen.*	Combretaceae	331	109
2	*CombretummolleG.Don.*	Combretaceae	286	74
3	*Acacia hockii De Willd.*	Mimosaceae	151	206
4	*Maytenussenegalensis (Lam.) Excell.*	Celastraceae	99	11
5	*Stereospermumkunthianum Cham*	Bignoniaceae	67	21
6	*Carissa edulis (Forssk.) Vahl*	Apocynaceae	55	3
7	*Dombeyaclaessensii De Wild.*	Sterculiaceae	43	11
8	*GrewiamollisJuss.*	Tiliaceae	41	77
9	*Brideliamicrantha (Hochst.) Baill.*	Euphorbiaceae	37	61
10	*BaikiaeainsignisBenth.*	Caesalpiniaceae	36	2
11	*Myrianthusholstii Engl.*	Moraceae	32	6
12	*FaureasalignaHarv.*	Proteaceae	27	
13	*Lanneaschimperi (A.Rich.) Engl.*	Anacardiaceae	27	2
14	*TerminaliaglaucescensBenth.*	Combretaceae	24	8
15	*ZiziphusabyssinicaHochst.exA.Rich.*	Rhamnaceae	24	18
16	*DalbergiamelanoxylonGuill. &Perr.*	Fabaceae	19	9
17	*GrewiatrichocarpaHochst.exA.Rich.*	Tiliaceae	16	31
18	*AlbiziagrandibracteataTaub.*	Mimosaceae	15	11

19	*LovoaswynnertoniiBak.f.*	Meliaceae	14	2
20	*Strychnosspinosa Lam*	Loganiaceae	13	
21	*Vitexdoniana Sweet*	Verbenaceae	13	
22	*Prosopispallida H.B.K*	Mimosaceae	11	1
23	*Sennaspectabilis (DC.) HS Irwin &Barneby*	Caesalpiniaceae	11	17
24	*Pterygotamildbraedii Engl.*	Sterculiaceae	10	5
25	*Acacia macrothyrsa Harms.*	Mimosaceae	9	
26	*Dicrostachyscinerea (L.) Wight. &Arn.*	Mimosaceae	9	163
27	*EntadaabyssinicaSteud.exA.Rich.*	Mimosaceae	8	
28	*LonchocarpuslaxiflorusGuill. &Perr.*	Fabaceae	8	79
29	*Prosopis sp.*	Mimosaceae	8	
30	*ProteamadiensisOliv.*	Proteaceae	7	
31	*ErythrinaexcelsaBak.*	Fabaceae	6	1
32	*Ficusglumosa Del.*	Moraceae	6	1
33	*Ormocarpumtrichocarpum (Taub.) Harms.*	Fabaceae	6	11
34	*SteganotaeniaaraliaceaHochst.*	Apiaceae	6	4
35	*BosciasalicifoliaOliv.*	Capparaceae	5	8
36	*EuclealatidensStapf.*	Ebenaceae	4	
37	*Lovoatrichilioides Harms*	Meliaceae	4	2
38	*Monanthotaxis sp.*	Annonaceae	4	3
39	*Commiphorabrownii (Arn.) Engl.*	Burseraceae	3	4
40	*Ficusbarteri Sprague*	Moraceae	3	
41	*Ficussycomorus Linn.*	Moraceae	3	8
42	*OurateabukobensisGilg.*	Ochnaceae	3	
43	*RhusnatalensisMeikle*	Anacardiaceae	3	1
44	*SecuridacalongipedunculataFres.*	Polygalaceae	3	5
45	*VangueriopsislongifloraVerdc.*	Rubiaceae	3	
46	*Zanthoxylumleprieurii (Guill. Et Perr.) Engl.*	Rutaceae	3	4
47	*Acacia polyacanthaWilld.*	Mimosaceae	2	4
48	*Acacia seyal Del.*	Mimosaceae	2	5
49	*AlbiziacoriariaWelw.exOliv.*	Mimosaceae	2	
50	*BrideliascleronueraPax.*	Euphorbiaceae	2	
51	*CommiphoramadagascariensiJacq.*	Burseraceae	2	5
52	*DombeyaburgessiaeHarv.*	Sterculiaceae	2	
53	*MaeruasessilifloraGilg.*	Capparaceae	2	
54	*PleurostyliacapensisLoes.*	Celastraceae	2	

55	*PsorospermumfebrifugumSpach.*	Guttiferae	2	
56	*Sclerocaryabirrea (A.Rich.) Hochst.*	Anacardiaceae	2	3
57	*VangueriaapiculataK.Schum.*	Rubiaceae	2	1
58	*Acacia brevispica Harms.*	Mimosaceae	1	7
59	*Antiaristoxicaria (Rumph.ex Pers.) Lesch.*	Moraceae	1	
60	*BrideliandellensisBeille*	Euphorbiaceae	1	
61	*Commiphora sp.*	Burseraceae	1	
62	*FicusnatalensisHochst.*	Moraceae	1	1
63	*FicusovataVahl*	Moraceae	1	1
64	*Gardenia imperialisK.Schum.*	Rubiaceae	1	1
65	*PavettacrassipesK.Schum.*	Rubiaceae	1	2
66	*Piliostigmathonningii Milne-Redh.*	Caesalpiniaceae	1	42
67	*Tamarindusindica L.*	Caesalpiniaceae	1	2
68	*Unidetified 2*		1	
69	*Acacia mearnsii De Wild.*	Mimosaceae		39
70	*Acacia senegal (L.) Wild.*	Mimosaceae		25
71	*Acacia sieberiana DC.*	Mimosaceae		25
72	*Acacia tortilis (Forssk.) Christ.*	Mimosaceae		1
73	*Allophylusrubifolius (Hochst. Ex A. Rich.) Engl.*	Sapindaceae		5
74	*Annonasenegalensis Pers.*	Annonaceae		8
75	*Balanitesaegyptiaca (L.) Del.*	Balanitaceae		14
76	*Celtisintegrifolia Lam.*	Ulmaceae		1
77	*ErythrococcabongensisPax.*	Euphorbiaceae		1
78	*Euphorbia venenificaKotschy*	Euphorbiaceae		18
79	*Ficusingens (Del.) Del.*	Moraceae		1
80	*Ficusplatyphylla Del.*	Moraceae		1
81	*FicustrichopodaBak.*	Moraceae		1
82	*Kigeliaafricana (Lam.) Benth.*	Bignoniaceae		3
83	*Lanneafulva Engl.*	Anacardiaceae		12
84	*Lanneahumilis (Oliv.) Engl.*	Anacardiaceae		3
85	*Lannea sp.*	Anacardiaceae		1
86	*Maeruaangolensis DC*	Capparaceae		2
87	*Mussaenda sp.*	Rubiaceae		3
88	*Unidentified 1*			1
89	*Ozoroainsignis Del.*	Anacardiaceae		6
90	*Sarcocephaluslatifolius (Smith.) Bruce*	Rubiaceae		1

91	*TrichiliaemiticaVahl*	Meliaceae		4
92	*Vernoniaamygdalina Del.*	Asteraceae		2
93	*VitellariaparadoxaGaertn.*	Sapotaceae		24

Table 1: Woody species composition in and around Agoro-Agu Central Forest Reserve. Values refer to number of individuals (abundance) of the species.

The species richness of 93 species recorded over an area of 8.64 ha reflects a low species diversity compared to other studies in tropical forests. Pappoe, Armah, Quaye, Kwakye and Buxton [19] recorded 73 tree species in a 2.25 ha area of a forest in Ghana; while 212 species were recorded in 12 1-ha plots in four forests of the Albertine Rift in western Uganda [20]. Shannon diversity index is considered as high when the calculated value is ≥3.0; medium when it is between 2.0 and 3.0; low between 1.0 and 2.0; and very low when it is ≤1.0 [21]. The significantly high Shannon's diversity index for the farmland reflects a greater species diversity around the forest than in the forest. Many studies [22,23] attribute such high species diversity on farmlands to the fact that these species are managed through cultivation or by protection when found growing naturally on the farmlands.

Density and Frequency

The density of a given species is expressed as a number of stems per hectare. Overall, the farmland had more dense (4,084.03m2/ha) woody species compared to the forest reserve (3,953.70 m2/ha). Density of the woody species in the higher size classes (≥25 cmdbh and 10-<25 cmdbh) were relatively higher in the forest reserve compared to the farmland. The forest reserve had 37.03 and 353.7 individuals per hectare, compared to the farmland with 14.5 and 89.8 individuals per hectare in the size classes of ≥25 cmdbh and 10-<25 cmdbh, respectively. However, the stand density of sapling and seedling were higher in the farmland with 205.6 and 3,774 individuals per hectare compared to 174 and 3,388 individuals per hectare in the forest reserve, respectively. Four species: T.*brownii, C. molle, A.hockii,* and*M.senegalensis* contributed to 59. 2 % of the total density in the forest reserve compared to 53.0 % by same number of species (*D.cinerea, A. hockii, T. brownii, L.laxiflorus and G.mollis*) in the farmland. The least five densest woody species (*B.ndellensis, F.ovata, G.imperialis, F.natalensis,* and*H.abyssinica*) in the forest contributed 0.08 % of the total stand density, while *E.bongensis, F.ingens, F. ovate, C.integrifolia,* and *F. natalensis* contributed only 0.03 % of the total stand density in the farmland. Frequency is the number of quadrats (expressed as a percentage) in which a given species occurred in the study area. The woody species in the forest reserve were not evenly distributed throughout the study quadrats. For example, *C. molle, T. brownii,* and *A. hockii*, were the top three most frequent species in the forest encountered in 74.1 %, 66.7 % , 59.3% of the whole sampled quadrats, respectively. On the other hand, 20 woody species (*T.indica, Commiphora sp., F.natalensis, D.burgessiae, S.longipedunculata, P.crassipes, A.coriaria, F.ovata, A.seyal, G.imperialis, P.thonningii, P.febrifugum, D.cinerea, A.toxicaria, B.scleronuera, O.bukobensis, M.sessiliflora, P.capensis*, and unidentified tree 2) in the forest were the least frequent species, each contributing 0.93 % of the sampled quadrats. Acacia *hockii, T. brownii,* and *G. mollis* were the top three most frequent species in the farmland encountered in 57.4 %, 42.6 % , 40.7% of the whole sampled quadrats, respectively. Nineteen woody species (*V.apiculata, E.bongensis, S.latifolius, F.ingens, R.natalensis, F.ovate, C.integrifolia, A.tortilis, F.natalensis, Lannea sp., F.glumosa, F.trichopoda, G.imperialis, P.pallida, A.brevispica, E.excels*, unidentified tree 1 [oyoro local dialect – Acholi], *F.platyphylla,* and *K.africana*) in the farmland were the least frequent with each contributing to 0.93 % of the sampled quadrats.

The relatively high density and frequency of some of the woody species e.g. *Acacia* species recorded may be attributed to seed dispersal abilities. Acacia species use the soil seed bank as a means of regeneration following disturbance like fire incidences. Wilson, Foxcroft, Geerts, Hoffman, MacFadyen, Measey, Mills, Richardson, Robertson and van Wilgen [24] report that the heat from fires stimulates mass germination, so that stands of these plants become denser after each fire. The higher density of woody species in the farmland may be attributed to some level of disturbance due to human activities. For example, grazing, fire and selective tree harvesting are considered major disturbances shaping species diversity and productivity [25]. In addition to topographical, climatic and edaphic factors, habitat preferences among the species, species characteristics for adaptation, degree of exploitation and conditions for regeneration could be the reasons for the variation in abundance and frequency woody species [26].

Dominance and Importance value index

The dominance of the woody species was determined from the space occupied by a species, its basal area (BA) per hectare. *Terminaliabrownii, B.aegyptiaca, P.thonningii, A.seyal,* and*C.molle* were the most dominant species in the farmland, with relative dominance of 32.5, 10.5, 7.8, 6.4 and 5.6, respectively. The least dominant species in the farmland were *V.apiculata, S.latifolius, R.natalensis, F.trichopoda,* and *Gardenia imperialis*, each with a relative dominance of 0.00. On the other hand, *Combretummolle, T.brownii, A.hockii, T.glaucescens,* and *F.glumosa* were the most dominant species in the forest, with the relative dominance of 20.6, 15.3, 14.1, 4.8, and 3.8, respectively. *Tamarindusindica, Commiphora sp., P.crassipes, P.thonningii,* and*A.toxicaria* were the least dominant species each contributing a relative dominance of 0.00. *Terminaliabrownii* had a lower relative coverage of 15.5 in the forest compared to 32.5 in the farmland, and had a higher relative density of 24.5 in the forest compared to 7.9 in the farmland. The importance value index (IVI) measures the overall importance of a species in a given area. Woody species showed a wide IVI variation, with values ranging from 50.8 to 0.2, and 48.3 to 0.2 in the forest and farmland, respectively. *Terminaliabrownii*was the most important species with the highest IVI value of 50.8 in the forest and 48.3 in the farmland. Eleven species in the forest, compared to four in the farmland, recorded the lowest IVI of 0.2. Some of the ecologically most important and dominant species (e.g. *T. brownii, C. molle,* and *A. hockii*) recorded in this study are usually well established in the tropics. For example, in his study in eastern Uganda, Tabuti [27], documented similar species in eastern Uganda. Some important species recorded in the present study are multipurpose in nature and are valued by many communities in Uganda. For example, *C. molle*and *Terminalia* species were documented as important medicinal species by communities in Ngai Sub-county in northern Uganda [28]. Acacia hockii is valued for construction purposes [29] and medicine in treating tuberculosis and allied diseases [30] in eastern Uganda. Two species of Lovoatrichilioides and Lovoaswynnertonii, which recorded low IVIs in the present study are threatened and are listed as vulnerable and endangered, respectively on the 2017 IUCN Plant Red List mainly due to high exploitation rates [31].

Population Structure and Regeneration Status

The overall population structure of the species encountered in the forest and farmland reflects an inverse J-shape (Figure 2). However, individual species showed varying patterns. For example, *Terminaliabrownii, C.molle*and*A.hockii* had a reverse J-shape size class distribution both in the forest and in the farmland (Figure 3). *Maytenussenegalensis*and*B.insignis*exhibited a relatively flat-shaped size class distribution in the two land use types. *Terminaliaglaucescens*and*G.mollis* had a J-shape size class distribution. Based on their population structures, the woody species were categorized into four diameter size class distribution patterns of 1 - <5, 5 - <10, 10 – 25, and >25 (Figure 2 and Figure 3). The first group was composed of species that exhibited higher number of individuals at the lowest diameter class and progressively declining numbers with increasing diameter classes. A total of 8,038 individuals of woody species were recorded in both the forest and farmland. Of these, 89 % individuals had less than 5 cm dbh; 4.7 % had between 5-<10 cm dbh; 5.5 % between 10-<25 cm dbh; and 0.6 % had greater than 25 cm dbh.

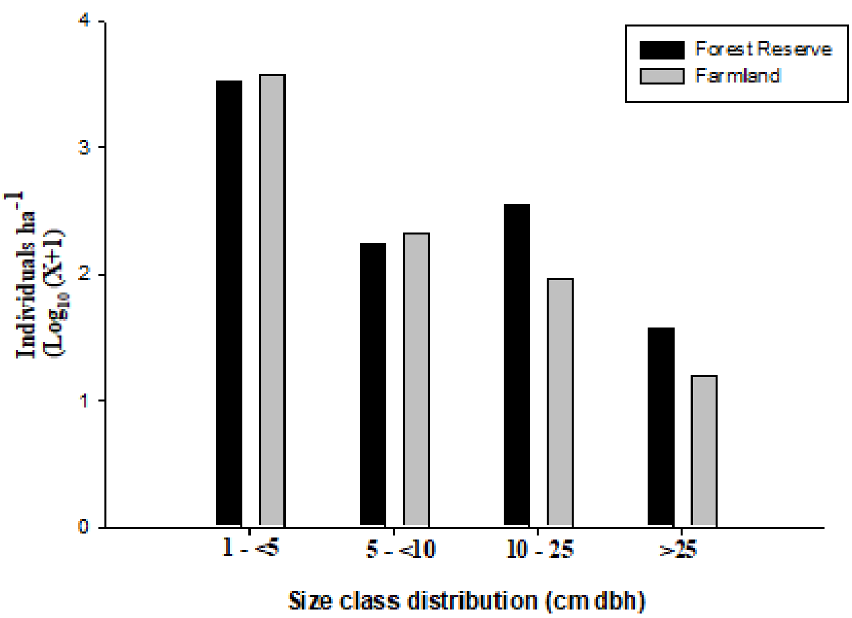

Figure 2: Population structure of woody species recorded in and around Agoro-Agu Central Forest Reserve

The pattern of population dynamics of seedlings, saplings and adults of a plant species can exhibit the regeneration profile, which is used to determine their regeneration status [32]. Generally, the population structure of woody species in and around the forest showed a reverse J-shape plot due to relatively more individuals in the smaller size classes (juveniles) compared to those in the larger size classes (mature). This trend is characteristic of species with good and stable regeneration, naturally replacing senesced individuals with seedlings and saplings [18,28]. The species that occurred only in seedling or sapling stages with few or no individuals in progressively higher classes (e.g. Terminaliaglaucescens) raise conservation concern as it is unlikely that these species populations can be maintained at the present level. This is because for a species to maintain a relatively constant population, more individuals are required in the smaller diameter size classes than in the larger ones [18]. Regeneration of a species is usually affected by anthropogenic and natural factors [33]. A possible reason for the occurrence of more seedlings and saplings with few or no mature trees of some of the recorded species in this study is that the mature trees could have been overexploited for construction materials and charcoal production. Similar reports indicated that woody species with DBH>30 cm were harvested by the local people for construction and charcoal making [34-35]. Forest fires and unstainable grazing practices are also a challenge to the plant communities in around the study area. Woody species with very few or no seedlings and saplings in a natural community (e.g. Albiziagrandibracteata and Terminaliaglaucescens) are under threat of local extinction. Therefore, deliberate efforts should be taken by all stakeholders to ensure that these plants are sustainably managed.

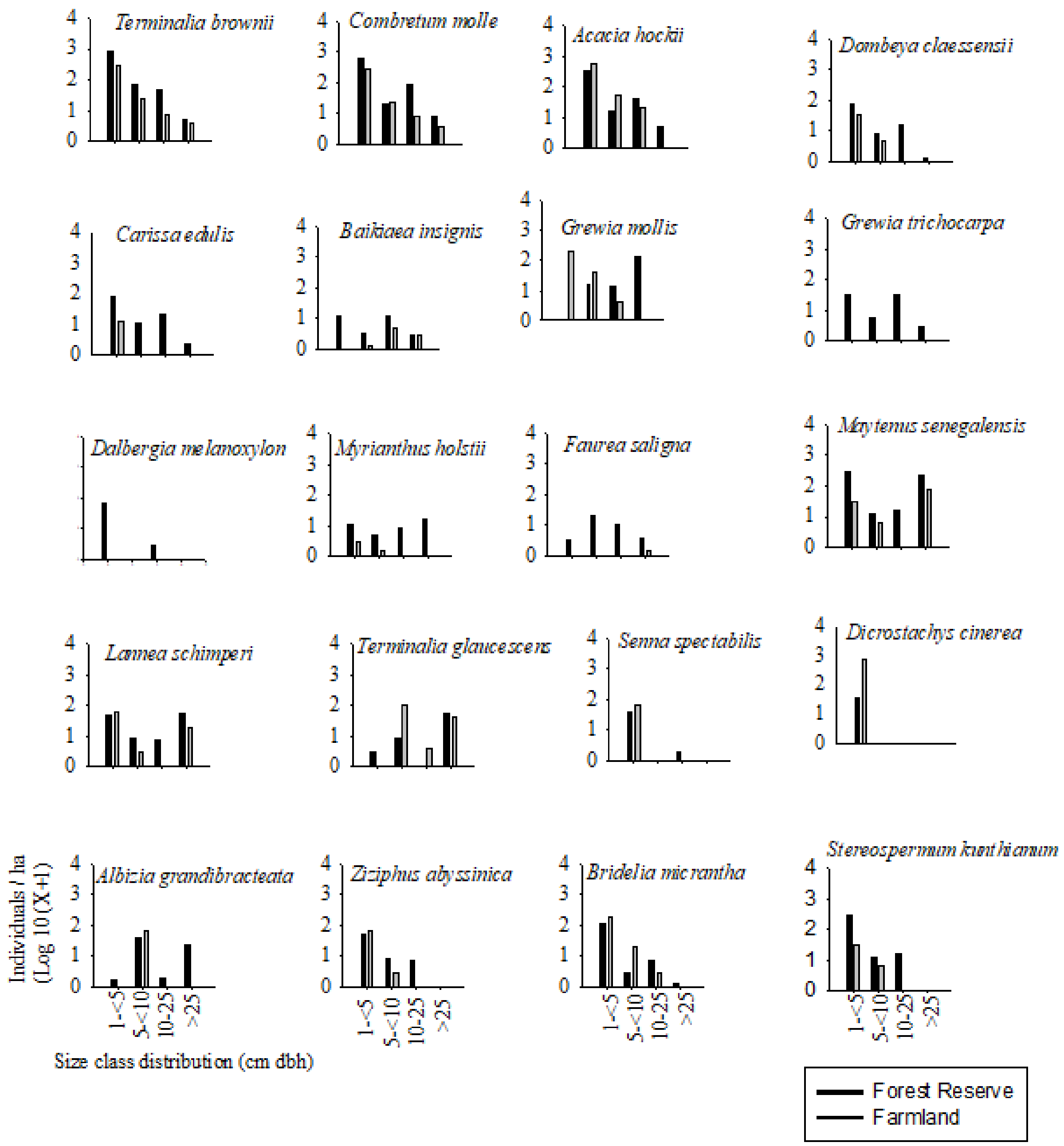

Fig. 1. Population structure of selected woody species in and around the Forest Reserve

Figure 3: Population structure of selected woody species in and around Agoro-Agu Central Forest Reserve

Conclusion and Recommendations

This study encountered a total of 93 woody species in 62 genera and 31 families. The results revealed higher woody species diversity in the farmland than in the forest reserve. The overall population structure of the species encountered both in the forest and farmland reflects an inverse J-shape, indicating a healthy population with active regeneration and recruitment of new individuals. However, not all individual species showed the same trend. This requires an intervention to ensure their sustainable management. Species with low ecological importance (IVI) such as *Lovoatrichilioides*and*Lovoaswynnertonii* need to be prioritized for conservation. For a sustainable management of the woody species, the local people of Agoro-Agu need to be sensitized on the status of the population structures and regeneration of the woody species so that they could promote sustainable management of the woody species of Agoro-Agu central forest reserve and allied landscapes.

Acknowledgment

This work was funded by the Wildlife Conservation Society. The author wishes to recognize the technical support received from Prof. John R. S Tabuti and Prof. MukadasiBuyinza from Makerere University, and Dr. Grace Nangendo from the Wildlife Conservation Society. The communities of Agoro-Agu willingly participated in the interviews. The National Forestry Authority granted permission to conduct the study.

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