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ARTICLE

Diversity and Abundance of Amenity Trees in the Premises of International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria

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ABSTRACT

Amenity trees are an essential element of most urban communities, contributing significantly to human well-being and improving environmental quality. Good knowledge of the diversity and abundance of trees in our environment and their importance can help promote conservation, which is essential for sustainability. This study aimed at assessing the diversity and abundance of amenity trees on the premises of the International Institute of Tropical Agriculture (IITA), Ibadan Nigeria. The institute was divided into working and residential areas. The trees in the study area were identified using a walking and windshield survey. A total population of 2626 trees from 126 species and 42 families were identified on the premises of IITA. The highest tree population of 523 trees was recorded in the Tropical Crescent residential area with 321 trees of *Lagerstroemia speciosa* being the most frequent species. Across working and residential areas, *Elaeis guineensis* was the most frequent species accounting for 19.92% of the total tree population. A Shannon-Wiener Diversity Index (H') of 3.383 and species evenness of 0.43 was obtained from the study area. The high values of diversity indices obtained indicate that IITA premises are rich in diverse tree species both indigenous and exotic hence should be referenced as a good urban landscape. The current management practices can be recommended for other institutions.

Keywords: Amenity trees; Species diversity; Abundance; IITA; Ibadan

1. Introduction

Amenity trees are trees that are not grown or managed for their value as timber or crop but provide benefits or values [1]. Examples include trees found in parks and other recreational spaces, lining

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the sides of streets, railways, rivers, and canals and in home gardens. These trees have a positive impact on air quality through the deposition of pollutants in the vegetation, sequestration of atmospheric carbon dioxide in woody biomass, and reduction of temperature and associated ozone formation [2-4].

The use of trees in urban settings for different purposes cannot be overemphasized as they provide lots of benefits for humans and the environment at large. Their functions vary depending on the species, the site and the purpose for which they are planted. Trees are purposefully planted in academic environments/institutions for a variety of benefits, including aesthetics and other environmental services [5-8].

The presence of trees, particularly long-lived species that can withstand periodic reproductive constraints without obvious adverse demographic consequences, defines the landscape [9,10]. Over the years, over-exploitation has been a major environmental problem facing our forest reserves which has led to a drastic loss of tree diversity [11]. According to Omoro et al. [12], urbanization and infrastructure development have caused some disturbance to the trees that were purposefully planted in many urban communities, as well as in a variety of institutions such as hospital grounds, school or college campuses, and research institutes.

Knowledge of the composition, tree diversity, and species richness of tree populations in communities is crucial for the planning and implementation of biodiversity conservation efforts [9]. Also, understanding the diversity and distribution of trees in an urban setting would help provide information on the status of these trees. Over the years IITA, Ibadan campus has been reported to have a good and serene green environment comprising a large number of tree species, however, there are no scientific records on frequency, distribution and species composition in the working and residential area. Therefore, to promote tree conservation, especially in this institute, it is essential to evaluate the diversity and abundance of trees as this will guide the selection of tree species to be planted to increase benefits to the residents and contributes to the conservation of rare and threatened species.

2. Methodology

2.1 Study area

The International Institute of Tropical Agriculture was founded in 1967 in Ibadan, Nigeria. It is an award-winning research-for-development (R4D) organization providing solutions to hunger, poverty, and the degradation of natural resources in Africa. Prior to the acquisition of the 1000 ha of land by IITA through the Federal Government of Nigeria, the most extensive land use pattern was arable and tree crop farming and about 3000 people lived in about twenty-eight villages scattered in this area [13].

The IITA, Ibadan campus (**Figure 1**) has an area of 10 km^2, (1000 hectares) with about 92 hectares of residential and working area (**Figure 2**). It is located between latitude 7°29'16.76" and 7°30'12" N; and between longitude 3°54'50.30" and 3°52'43.55" E and at an altitude of 227 m above sea level.

The rainfall pattern is bimodal with an annual total ranging from 1,300-1,500 mm most of which falls between May and September. The average daily temperature ranges between 21 °C and 23 °C while the maximum is between 28 °C and 34 °C. Radiation is about 5285 MJ/m^2/year. The mean relative humidity is in the range of 64% to 83% [14].

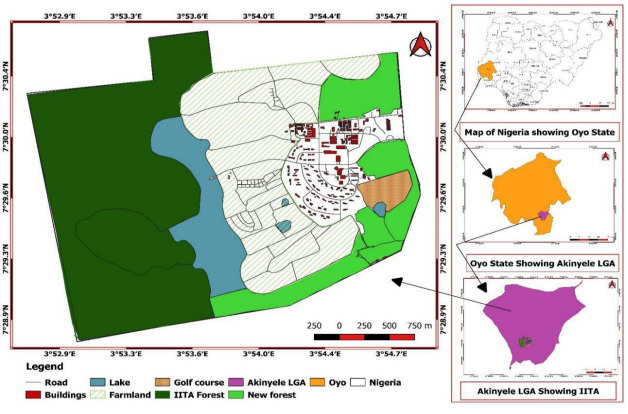

Figure 1. Map of the International Institute of Tropical Agriculture.

Source: Produced from QGIS, 2021.

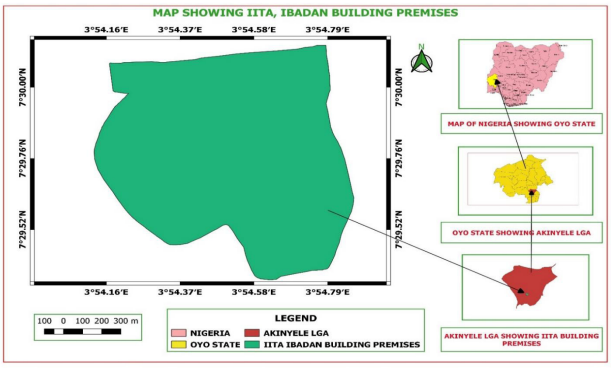

Figure 2. Map of the residential and working areas of the International Institute of Tropical Agriculture.

Source: Produced from QGIS, 2021.

2.2 Method of data collection

This study covers the working and residential premises of the International Institute of Tropical Agriculture, (IITA), Ibadan campus (**Figure 2**). Trees within these premises were counted and identified to species level using walking and wind shield survey methods. The structure of the amenity tree population such as species composition, frequency, and relative frequency was recorded.

2.3 Data analysis

Relative Density (RD) was obtained using the formula given by Oduwaiye et al. [15]:

$$RD = \frac{n_i}{N} \times 100$$

where RD = relative density, n_i = number of individuals of species and N = total number of individuals in the entire population.

Tree population and diversity were analyzed using the following species diversity indices.

A mathematical technique that takes into account the species richness and abundance was used to determine tree diversity. The Shannon-Wiener diversity index was calculated using the following equation provided by Price [16]:

$$H^1 = \sum s\ i{=}1\ pi\ Lnpi \ldots\ldots$$

H^1 is the Shannon diversity index, S is the total number of species in the sample plot, pi is the proportion of a species relative to the total number of plants in the sample plots and Ln is the natural logarithm.

Species evenness (E) in each of the plots was determined using Shannon's equitability (E_H) as stated by Kent and Coker [17]:

$$E = \frac{H^1}{Ln(S)}$$

S is the total number of species in each premises (working and residential premises).

3. Results

Tree species diversity and abundance in the study area are presented in **Table 1**. The working and residential areas contained a total of 2626 individual trees from 126 different tree species from 42 different families. The Shannon-Wiener index of diversity was 3.38 and the species evenness was 0.43.

Table 2 shows the origin, frequency and relative frequency of tree species encountered in the study area. The oil palm *Elaeis guineensis, Lagerstroemia speciosa, Roystonea regia and Tabebuia rosea* were present at frequencies (and relative frequencies) of 523 (19.92%), 321 (12.22%), 217 (8.26%) and 173 (6.59%), respectively. Of all the species encountered, *Elaeis guineensis* was the most frequent in the study area.

Table 3 shows the family distribution of the species encountered on the premises of IITA, Ibadan. *Arecaceae* were the most frequent species with a relative frequency of 32.83% followed by *Fabaceae* with 13.37% and *Lythraceae* with 12.22%.

Table 1. Tree species diversity and abundance in the study area.

Diversity indices	Values
Total No. of individual	2626
No. of individual species	126
No. of family	42
Shannon diversity index (H^1)	3.383
Evenness	0.43

Table 2. Frequency, origin, family and relative frequency of individual trees by species on IITA, Ibadan campus.

S/N	Tree species	Origin	Family	Frequency	Relative frequency (%)
1	*Adansonia digitata*	I	Malvaceae	1	0.04
2	*Afzelia africana*	I	Fabaceae	1	0.04
3	*Albizia ferruginea*	I	Fabaceae	2	0.08
4	*Albizia glaberrima*	I	Fabaceae	2	0.08
5	*Albizia lebbeck*	E	Fabaceae	2	0.08
6	*Albizia saman*	E	Fabaceae	1	0.04
7	*Albizia zygia*	I	Fabaceae	13	0.50
8	*Allophylus africanus*	I	Sapindaceae	2	0.08
9	*Alstonia boonei*	I	Apocynaceae	3	0.11
10	*Anacardium occidentalis*	E	Anacardiaceae	1	0.04
11	*Anogeisus leiocarpus*	I	Combretaceae	2	0.08
12	*Anthocleista djalonensis*	I	Loganiaceae	1	0.04
13	*Anthocleista nobilis*	I	Gentianaceae	6	0.23
14	*Anthocleista vogelii*	I	Loganiaceae	2	0.08
15	*Anthonotha macrophylla*	I	Caesalpinioideae	2	0.08
16	*Antiaris toxicaria*	I	Moraceae	6	0.23
17	*Araucaria heterophylla*	E	Araucariaceae	3	0.11
18	*Artocarpus altilis*	E	Moraceae	8	0.30
19	*Artocarpus communis*	E	Moraceae	2	0.08
20	*Artocarpus heterophyllus*	E	Moraceae	4	0.15
21	*Asimina tribola*	E	Annonaceae	4	0.15
22	*Azadirachta indica*	E	Meliaceae	7	0.27
23	*Bauhinia purpurea*	E	Fabaceae	5	0.19
24	*Bauhinia variegata*	E	Fabaceae	2	0.08
25	*Blighia sapida*	I	Sapindaceae	15	0.57
26	*Bombacopsis glabra*	E	Bombacaceae	1	0.04
27	*Bombax buonopozense*	I	Malvaceae	2	0.08
28	*Borassus aethiopum*	I	Arecaceae	14	0.53
29	*Bosqueia angolensis*	I	Moraceae	4	0.15
30	*Brachystegia eurycoma*	I	Fabaceae	8	0.30
31	*Calliandra haematocephala*	E	Fabaceae	5	0.19
32	*Callophyllum macrocarpum*	E	Clusiaceae	4	0.15
33	*Carica papaya*	E	Caricaceae	5	0.19
34	*Cassia fistula*	E	Fabaceae	8	0.30
35	*Cassia javanica*	E	Fabaceae	6	0.23
36	*Cassia nodosa*	E	Fabaceae	3	0.11
37	*Casuarina equisetifolia*	E	Casuarinaceae	11	0.42
38	*Ceiba pentandra*	I	Malvaceae	8	0.30
39	*Chrysophyllum albidum*	I	Sapotaceae	4	0.15

Table 2 continued

S/N	Tree species	Origin	Family	Frequency	Relative frequency (%)
40	*Citrus reticulata*	E	Rutaceae	33	1.26
41	*Citrus sinensis*	E	Rutaceae	3	0.11
42	*Cleistopholis patens*	I	Annonaceae	4	0.15
43	*Cnetis ferruginea*	I	Connaraceae	2	0.08
44	*Cocos nucifera*	E	Arecaceae	31	1.18
45	*Cola acuminata*	I	Malvaceae	2	0.08
46	*Cola gigantea*	I	Malvaceae	3	0.11
47	*Cola nitida*	I	Malvaceae	40	1.52
48	*Dacryodes edulis*	I	Burseraceae	6	0.23
49	*Dactyladenia barteri*	I	Chrysobalanceae	1	0.04
50	*Daniellia oliveri*	I	Fabaceae	6	0.23
51	*Delonix regia*	E	Fabaceae	36	1.37
52	*Dichrostachys cinerea*	I	Fabaceae	6	0.23
53	*Dobera glabra*	I	Salvadoraceae	10	0.38
54	*Duranta repens*	E	Verbenaceae	3	0.11
55	*Elaeis guineensis*	I	Arecaceae	523	19.92
56	*Entandrophragma angolense*	I	Meliaceae	1	0.04
57	*Enterolobium cyclocarpum*	E	Fabaceae	7	0.27
58	*Erythrina variegata*	E	Fabaceae	1	0.04
59	*Erythrophleum suaveolens*	I	Leguminosae	1	0.04
60	*Eucalyptus camaldulensis*	E	Myrtaceae	4	0.15
61	*Eucalyptus tereticornis*	E	Myrtaceae	33	1.26
62	*Eugenia uniflora*	E	Myrtaceae	3	0.11
63	*Ficus aurea*	E	Moraceae	2	0.08
64	*Ficus benjamina*	E	Moraceae	3	0.11
65	*Ficus exasperata*	I	Moraceae	4	0.15
66	*Ficus lutea*	I	Moraceae	27	1.03
67	*Ficus mucuso*	E	Moraceae	1	0.04
68	*Gliricidia sepium*	E	Fabaceae	7	0.27
69	*Gmelina arborea*	E	Lamiaceae	1	0.04
70	*Hildegardia barteri*	I	Malvaceae	44	1.68
71	*Holarrhena floribunda*	I	Apocynaceae	5	0.19
72	*Hura crepitans*	E	Euphorbiaceae	34	1.29
73	*Irvingia gabonensis*	I	Irvingiaceae	2	0.08
74	*Jacaranda mimosifolia*	E	Bignoniaceae	3	0.11
75	*Kigelia africana*	I	Bignoniaceae	1	0.04
76	*Lagerstroemia speciosa*	E	Lythraceae	321	12.22
77	*Leucaena leucocephala*	E	Fabaceae	9	0.34
78	*Mangifera indica*	E	Anacardiaceae	28	1.07
79	*Milicia excelsa*	I	Moraceae	12	0.46

Table 2 continued

S/N	Tree species	Origin	Family	Frequency	Relative frequency (%)
80	*Milletia thonningii*	I	Fabaceae	10	0.38
81	*Monodora myristica*	I	Annonaceae	6	0.23
82	*Monodora teluifolia*	I	Annonaceae	24	0.91
83	*Morinda lucida*	I	Rubiaceae	2	0.08
84	*Moringa oleifera*	I	Moringaceae	2	0.08
85	*Myrianthus arboreus*	I	Urticaceae	1	0.04
86	*Nauclea diderrichii*	I	Rubiaceae	1	0.04
87	*Newbouldia laevis*	I	Bignoniaceae	6	0.23
88	*Parkia biglobosa*	I	Fabaceae	2	0.08
89	*Peltophorum pterocarpum*	E	Fabaceae	72	2.74
90	*Persea americana*	E	Lauraceae	9	0.34
91	*Phoenix reclinata*	I	Arecaceae	77	2.93
92	*Pinus caribaea*	E	Pinaceae	50	1.90
93	*Plumeria alba*	E	Apocynaceae	7	0.27
94	*Plumeria rubra*	E	Apocynaceae	14	0.53
95	*Polyalthia longifolia*	E	Annonaceae	90	3.43
96	*Psidium guajava*	E	Myrtaceae	6	0.23
97	*Pterocarpus osun*	I	Leguminosae	4	0.15
98	*Pterocarpus santalinoides*	I	Fabaceae	3	0.11
99	*Pterocarpus soyauxii*	I	Fabaceae	6	0.23
100	*Pterospermum heterophyllum*	E	Malvaceae	6	0.23
101	*Pycnanthus angolensis*	I	Myristicaceae	7	0.27
102	*Pyrus communis*	E	Rosaceae	1	0.04
103	*Rauvolfia vomitoria*	I	Apocynaceae	2	0.08
104	*Ravenala madagascariensis*	I	Strelitziaceae	6	0.23
105	*Ricinodendron heudolotii*	I	Euphorbiaceae	1	0.04
106	*Roystonea regia*	E	Arecaceae	217	8.26
107	*Senna alata*	E	Fabaceae	1	0.04
108	*Senna fistula*	E	Fabaceae	127	4.84
109	*Spathodea campanulata*	I	Bignoniaceae	6	0.23
110	*Sterculia tragacantha*	I	Sterculiaceae	6	0.23
111	*Syzygium malaccense*	E	Myrtaceae	115	4.38
112	*Tabebuia rosea*	E	Bignoniaceae	173	6.59
113	*Tectona grandis*	E	Lamiaceae	9	0.34
114	*Terminalia catappa*	I	Combretaceae	43	1.64
115	*Terminalia ivorensis*	I	Combretaceae	1	0.04
116	*Terminalia mantaly*	E	Combretaceae	4	0.15
117	*Terminalia superba*	I	Combretaceae	5	0.19
118	*Theobroma cacao*	E	Malvaceae	12	0.46
119	*Treculia africana*	I	Moraceae	6	0.23

Table 2 continued

S/N	Tree species	Origin	Family	Frequency	Relative frequency (%)
120	*Trema orientalis*	I	Cannabaceae	17	0.65
121	*Trichilia africana*	I	Meliaceae	5	0.19
122	*Trichilia megalantha*	I	Meliaceae	2	0.08
123	*Trichilia monadelpha*	I	Meliaceae	12	0.46
124	*Trilepisium madagascariense*	I	Moraceae	3	0.11
125	*Triplochiton scleroxylon*	I	Malvaceae	3	0.11
126	*Zanthoxylum zanthoxyloides*	I	Rutaceae	1	0.04
	Total			2626	100.00

Source: Field survey 2021.

Table 3. Family distribution of tree species in the study area.

S/N	Family	No. of SPP/Family and abundance	Relative frequency
1	Anacardiaceae	29	1.10
2	Annonaceae	128	4.87
3	Apocynaceae	31	1.18
4	Araucariaceae	3	0.11
5	Arecaceae	862	32.83
6	Bignoniaceae	189	7.20
7	Bombacaceae	1	0.04
8	Burseraceae	6	0.23
9	Caesalpinioideae	2	0.08
10	Cannabaceae	17	0.65
11	Caricaceae	5	0.19
12	Casuarinaceae	11	0.42
13	Chrysobalanceae	1	0.04
14	Clusiaceae	4	0.15
15	Combretaceae	55	2.09
16	Connaraceae	2	0.08
17	Euphorbiaceae	35	1.33
18	Fabaceae	351	13.37
19	Gentianaceae	6	0.23
20	Irvingiaceae	2	0.08
21	Lamiaceae	10	0.38
22	Lauraceae	9	0.34
23	Leguminosae	5	0.19
24	Loganiaceae	3	0.11
25	Lythraceae	321	12.22
26	Malvaceae	121	4.61
27	Meliaceae	27	1.03
28	Moraceae	82	3.12
29	Moringaceae	2	0.08

Table 3 continued

S/N	Family	No. of SPP/Family and abundance	Relative frequency
30	Myristicaceae	7	0.27
31	Myrtaceae	161	6.13
32	Pinaceae	50	1.90
33	Rosaceae	1	0.04
34	Rubiaceae	3	0.11
35	Rutaceae	37	1.41
36	Salvadoraceae	10	0.38
37	Sapindaceae	17	0.65
38	Sapotaceae	4	0.15
39	Sterculiaceae	6	0.23
40	Strelitziaceae	6	0.23
41	Urticaceae	1	0.04
42	Verbenaceae	3	0.11
Total		2626	100.00

4. Discussion

The IITA Ibadan premises comprise a diverse set of indigenous and exotic tree species. The surveyed area of 92 ha containing 2626 trees translates to a density of 28.54 trees per ha. Unfortunately, there is no data on tree densities for other African Institutions or parks to compare this result. The trees in IITA are generally in good condition with a few exceptions of exotic species. The placement of the trees serves largely the purpose of shading in the residential area with a good portion being used as fruit trees. The placement in the working area is more for ornamental purposes and to line streets and parking areas. Many trees are old and have been exposed to recent bad weather events. IITA does replace dead and damaged trees and does conduct management operations to retain trees in good condition. IITA staff and residents consider the presence of the trees as beneficial irrespective of the trees' purpose and use. Most of the trees are beneficial to the people on the premises as they provide shade and fruit and improve the aesthetics, which are some of the important benefits of amenity trees. The total of 2626 individual trees; with 126 different tree species from 42 different families compares positively with the results obtained by Agbelade et al. [18] on the 'Assessment of Urban Forest Tree Species Population and Diversity in Ibadan, Nigeria', who recorded a total number of 155 individual trees belonging to 16 families. This implies that the study area, despite being a small fragment of Ibadan city is well diversified comprising more tree species at a higher population density than other similar sites. The abundance and diversity of trees in the IITA area can be linked to the policy of conservation guiding the management of trees on the premises. IITA has a nursery of indigenous African trees and focuses on propagating rare and threatened species to contribute to the conservation of such species.

The benefits of the trees to the staff and residents on the premises are variable and largely to provide shade (e.g. *Lagerstroemia speciosa*, *Roystonea regia*, *Senna fistula*, *Peltophorum pterocarpum*), provision of food/fruits (e.g. *Citrus* spp, *Elaeis guineensis*, *Dacryodes edulis*, *Cocos nucifera*, *Syzygium malaccense*, *Persea americana*) improving the aesthetics (e.g. *Polyalthia longifolia*, *Roystonea regia*, *Ravenala madagascariensis*).

The study area is dominated by the family Arecacea with 862 individuals, mostly oil palm (*Elaeis guineensis*) which are almost all remnants of the previous land use by the smallholders using the land before the installation of IITA. These palms are still harvested and maintained by the successors of the villagers who were displaced. The still high numbers

of oil palm are thus due to the continued use that has prevented any felling by the current residents. Other dominant families include Fabaceae with 351 individuals, mostly serving aesthetic purposes and Lythraceae having 321 individuals.

The Shannon Diversity Index (H') in the study area was 3.38, which indicates a high tree species diversity. These findings are similar to the results obtained by Haastrup et al. [19] for the Owo forest reserve and Ogundele et al. [20] for the Akure forest reserve with species diversity of 3.42 and 3.18, respectively. The H' value of this study is similar to the one recorded by Agbelade et al. [18] who recorded a 3.35 Shannon Diversity Index (H'). Across the available data, it can be postulated that the tree species diversity in the work and residential areas of IITA is amongst the highest recorded in southwest Nigeria.

5. Conclusions

The results obtained from this study revealed the diversity and abundance of trees in the working and residential areas of the IITA, Ibadan campus. The study area comprised a lot of tree species when compared with the results of studies obtained in the Ibadan metropolis and some other forest reserves in southwest Nigeria. The species in this premise are said to have been well conserved and managed over the years. Some of the indigenous trees which are now endangered were encountered on this site, therefore, this study area can be said to be a home of different species which are of great importance. The various species encountered during this study revealed that IITA, Ibadan is a good example of urban green space; hence, the results from this study can be used in developing the database required for urban green space management.

Authors' Contributions

Dr. Stefan Hauser facilitated access to the premises, liaised with IITA management and residents to obtain permission to enter the working area and private residential spaces, reviewed the manuscript.

Yewande Owoeye collected and compiled the data on amenity trees from the International Institute of Tropical Agriculture IITA, Ibadan.

Conflict of Interest

The authors declare no conflict of interest.

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