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Ecological characterization of avenue trees in Federal University of Agriculture, Abeokuta, Ogun state, Nigeria

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ABSTRACT

Avenue trees are urban trees and they are very important for their strong environmental influence within urban landscapes. This research focuses on the assessment of avenue tree species population and diversity within the Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria. A complete enumeration of the trees planted beside the major road network at the study location was done. All the avenue trees with diameter at breast height (dbh) ≥ 10cm were identified and measured, height was measured and their frequencies were taken. A total of 781 trees belonging to 8 families and comprising 12 species were found within the study area. The two most abundant species and families were *Gmelina arborea* of the Verbenaceae family and *Albizia zygia* of the Fabaceae family (601 and 71 stands) respectively. The Shannon-Weiner diversity index was low= 0.92, the evenness was very low = 0.14, and the Simpson's diversity index was 0.4. The DBH with the highest frequency was 10-29.9cm (47.9%) and the height with the highest frequency was 11-15.9m (49.04%). The study revealed very low species diversity and extremely low evenness in the study area. It is recommended that species diversification should be prioritized to enhance structural diversity and ecological resilience.

Keywords: FUNAAB-Urban Trees-Avenue Trees-Biodiversity Indices-Ecological resilience.

INTRODUCTION

Urban forests comprise all trees, shrubs, lawns, and other forms of vegetation found within urban environments, and they provide a wide range of ecosystem services essential to human well-being (Baró *et al.* 2014, Akale 2021). These services include air purification, climate regulation, urban temperature moderation, stormwater management, noise reduction, biodiversity conservation, and the provision of recreational and aesthetic benefits (Sokolova *et al.* 2025). As urbanization continues to expand globally, urban forests have become increasingly important for improving environmental quality and enhancing the livability of cities (Qu *et al.* 2025).

Trees constitute the structural and functional backbone of urban forests and ecosystems (Onefeli *et al.* 2023). Their ecological importance is reflected in their ability to regulate temperature, influence freshwater flows, sequester carbon, improve air quality, and mitigate the impacts of urban heat islands (Ellison *et al.* 2017, Li *et al.* 2015, Oyerinde *et al.* 2018). Urban trees also reduce surface and air temperatures through canopy shading, evapotranspiration, and evaporative cooling processes, thereby improving thermal comfort in built environments (Hesslerová *et al.* 2013).

However, the influence of trees on urban climate may vary depending on environmental conditions. In colder regions, for example, forest canopies may contribute to localized warming by absorbing solar

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radiation and trapping heat near the ground surface (Li *et al.* 2015). Beyond climate regulation, urban trees provide habitats for birds, insects, and other wildlife species, thereby contributing significantly to the maintenance of urban biodiversity (Jovanović *et al.* 2025). In addition, urban trees generate important social and economic benefits, many of which are often overlooked, including improvements in public health, psychological well-being, and urban aesthetics (Ellison *et al.* 2017).

Urban forests occur in different forms, including forests adjacent to urban centres, natural forests under urban influence, designated parks, protective tree belts, watershed protection forests, and avenue trees (Fuwape and Onyekwelu 2011). Among these, avenue trees are particularly important because of their strong visual, environmental, and social influence within urban landscapes. Avenue trees are generally described as trees planted in a uniform arrangement along roadsides or rights-of-way, often giving the impression of simultaneous establishment (Olokeogun *et al.* 2020). Although avenue trees represent only a small proportion of the total urban forest, their impact on urban life is highly significant due to their roles in shade provision, beautification, environmental regulation, and pedestrian comfort (Oyerinde *et al.* 2018). Their strategic placement along transportation corridors also makes them highly visible components of urban green infrastructure.

Within academic environments, the significance of urban trees extends beyond environmental services (Olusola and Oyerinde 2025). Studies have shown that tree cover within educational institutions positively correlates with students' academic performance and psychological well-being (Hudson and Sander 2021). The presence of trees and green spaces has been associated with improved concentration, reduced stress levels, enhanced mental restoration, and better learning outcomes (Bernardo *et al.* 2021). Consequently, avenue trees within university campuses contribute not only to ecological sustainability but also to the creation of healthier and more conducive learning environments.

Despite the numerous benefits associated with urban and avenue trees, many urban areas in developing countries such as Nigeria, still lack adequate information regarding the composition, diversity, abundance, and structural characteristics of their urban forests (Adeyemi and Shackleton 2024). Such information is essential for sustainable tree management, biodiversity conservation, and long-term urban planning. Assessing the species diversity and relative abundance of avenue trees provides valuable insight into the ecological structure and stability of urban forests and supports informed management decisions (Oyerinde *et al.* 2018). Diversity assessments are particularly important because urban forests dominated by only a few species are often more vulnerable to pests, diseases, and environmental disturbances (Onefeli *et al.* 2023). Conversely, diverse tree populations generally exhibit greater ecological resilience and sustainability (Keesing and Ostfeld 2024).

The Federal University of Agriculture, Abeokuta is one of the foremost universities in Nigeria and possesses a substantial population of avenue trees distributed across its campus landscape. These trees contribute significantly to the environmental quality and aesthetics of the university environment. However, despite their importance, there is limited comprehensive documentation on the diversity, abundance, and biometric characteristics of these avenue tree species there. This creates an important knowledge gap regarding the composition and structural characteristics of the campus urban forest.

Addressing this gap is necessary for effective planning, conservation, and sustainable management of the university's green infrastructure. Information on species

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diversity, relative abundance, and structural distribution can guide tree planting programmes, improve species selection strategies, and enhance the ecological resilience of the campus landscape (Das *et al.* 2026). Furthermore, such information can support policies aimed at promoting biodiversity conservation, climate adaptation, and environmental sustainability within university campuses (Oyerinde *et al.* 2018). Therefore, this study aimed to examine the diversity and relative abundance of avenue tree species within FUNAAB, by assessing the taxonomy and frequency distribution, diameter distribution, height distribution, diversity indices distribution, and relative distribution of native and exotic avenue trees within FUNAAB, in order to provide baseline information for sustainable urban forest management and future ecological planning within the university environment.

METHODOLOGY

Description of study area

This study was conducted within the premises of the Federal University of Agriculture, Abeokuta (FUNAAB) (Figure 1). Abeokuta lies on latitude 7° 9'39" N and longitude 3° 20'54" E. It is the largest city and the state capital of Ogun State. The city has a tropical climate. When compared with winter, the summers have much more rainfall. This location is classified as a tropical wet and dry climate, known as a tropical savanna climate. There is a noticeable dry season in the winter and a wet season in the summer, which defines this climate type. The temperature here averages 27.1 °C. Precipitation here averages 1238mm. The state has two main types of vegetation, namely tropical rainforest and guinea savanna. Abeokuta lies within the tropical rainforest, as well as other coastal areas in the state (Olabode *et al.* 2025).

The University (FUNAAB) is situated in Abeokuta as shown in Figure 1. It was established on the 1st of January 1988 by the Federal Government of Nigeria. The University occupies 10,000-hectare as a campus, with coordinates 7.22976^{0}N and 3.43989^{0}E, located next to the Ogun-Oshun River Basin Development Authority on the Abeokuta-Ibadan Road in the North Eastern end of the city. The Federal University of Agriculture is located about 15 km from Abeokuta City Centre (Lawal-Adebowale and Oyekunle 2014). It is a tertiary institution that accommodates wide varieties of urban trees, ranging from open grown trees to avenue tree species.

Data collection

Inventory data, such as taxonomy and mensuration were obtained through a field survey (on-site). Complete enumeration of tree species was carried out on the major road network within the University campus, from the main gate of the campus, to where classrooms and lecture theatres were present. The trees enumerated within 5m radius from the major road network. Trees located within 5m from the roadway were classified as avenue trees because they are spatially and functionally associated with roadside planting and management. Trees beyond this distance were excluded to avoid the inclusion of non-roadside urban vegetation, and to reduce sampling ambiguity. Variables such as diameter at breast height (DBH) and total height (TH) of all tree encountered were measured using girth tape and Spiegel relaskop (Oyerinde *et al.* 2018). All the avenue trees were identified with their scientific names.

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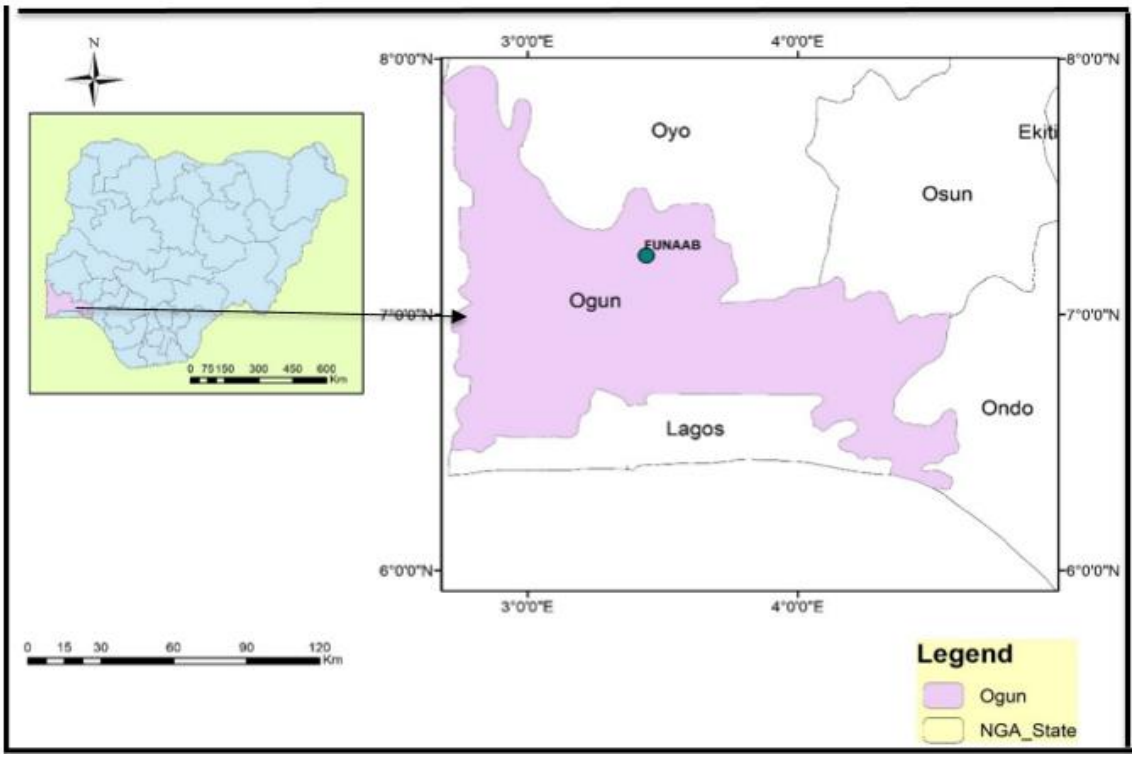

Figure 1: Map of Nigeria showing the location of study area in Ogun State

Data analysis

The collected data were analysed for relative frequency, taxonomy and frequency distribution, diameter distribution, height distribution, Shannon-Wiener diversity index (H '), Species Evenness, Simpson's diversity index, and relative distribution of native and exotic avenue tree species within the study area.

Species composition was identified by calculating relative frequency according to Olokeogun *et al.* (2020).

Species diversity was computed using Olokeogun *et al.* (2020)

$$H' = -\sum_{i=1}^{R} P_i \ ln(P_i) \ldots\ldots\ldots \text{equation 1}$$

Where: H ' is the Shannon-Wiener diversity index; R is the total number of species in the study area P_i; is the proportion of R made up of the i_{th} species and; ln is natural logarithm.

Species Evenness was computed using Oyerinde *et al.* (2018)

Shannon's equitability equation was adopted to obtain the species evenness.

$$E_H = \frac{H'}{H_{max}} = \sum_{i=1}^{S} P_i \ ln(P_i) \div ln(S) \ldots\ldots\ldots\ldots\ldots\ldots \text{equation 2}$$

Simpson's diversity index was computed using Olokeogun *et al.* (2020)

$$D = 1 - \left(\frac{\sum n_i(n_i-1)}{N(N-1)}\right) \ldots\ldots \text{equation 3}$$

Where; D is Simpson's diversity; n_i is the abundance of the ith species and; N is the abundance of the total stand.

RESULTS

Taxonomy and frequency distribution of the avenue trees in FUNAAB

The species composition of the all the avenue trees is presented in Table 1. The table shows that there are 781 avenue trees comprising of 12 species distributed among 8 families planted, in the study area. *Gmelina arborea* had the highest relative frequency of 76.89% followed by *Albizia zygia* (9.11%), *Cassia fistulata* (6.16%), *Terminalia mentaly* (3.21%), *Leucaena*

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leucoceophala (2.18%), *Bauhinia spp.* (0.77%), *Azadiracta indica* (0.64%), *Mepotium toxiferum, Isoberilina doka* and *Margaritagia discoidea* (0.26%), and while *Burretiodendron hsienmu* and *Antidesma thwaitesianum* had the least relative frequency (0.13%).

Table 1: Taxonomy and frequency distribution of avenue tree species in FUNAAB

S/N	Scientific name	Common name	Frequency	Relative frequency (%)
1	**Gmelina arborea*	Melina	601	76.95
2	***Albizia zygia*	Mepepe	71	9.09
3	**Cassia fistulata*	Golden shower tree	48	6.15
4	**Terminalia mentally*	Umbrella Tree	25	3.20
5	**Leucaena leucoceophala*	White lead tree	17	2.18
6	**Bauhinia purpurea*	Orchid Tree	6	0.77
7	**Azadirachta indica*	Neem	5	0.64
8	**Metopium toxiferum*	Poison wood	2	0.26
9	***Isoberilina doka*	Abogo	2	0.26
10	***Margaritaria discoidea*	Pheasant berry	2	0.26
11	**Burretiodendron hsienmu*	Hseinmu wood	1	0.13
12	**Antidesma thwaitesianum*	Mamao	1	0.13
	Total		**781**	**100**

Note: * indicates exotic species, while ** represents species indigenous to Nigeria

Diameter distribution of the avenue trees in FUNAAB

Figure 2 shows the diameter class distribution graph of avenue trees in the study area. The diameter class of avenue tree species encountered in the study area ranged from (10-110cm) though the result revealed that the diameter class of 10-29.9cm had the highest frequency of trees with percentage frequency of 47.9%, followed by 30-49.9cm class with percentage frequency of 39.1%, while 50-69.9cm had (9.2%), 70-89.9cm (3.6%) and 90-109.9cm had the least percentage frequency of 0.3% respectively.

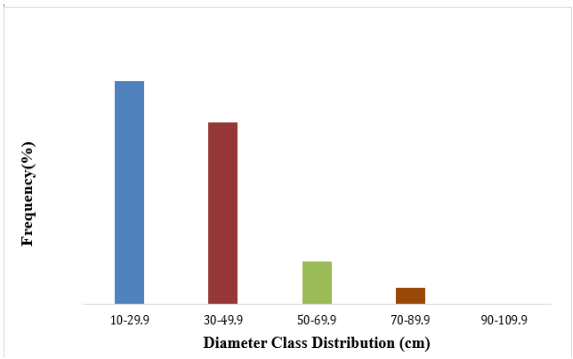

Fig. 2: Diameter distribution class of avenue trees in FUNAAB

Height distribution of the avenue trees in FUNAAB

The result in Figure 3 shows the height distribution class of the avenue trees encountered in the study area. The height class ranged between (5-20m) and the result

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revealed that the height class of 11-15.9m had the highest frequency of trees with percentage frequency of 49.04%, followed by 6-10.9m (43.02%), and the height class of 16-20m had 7.43% while the 0-5.9m height class had the least percentage frequency of 0.51%, respectively.

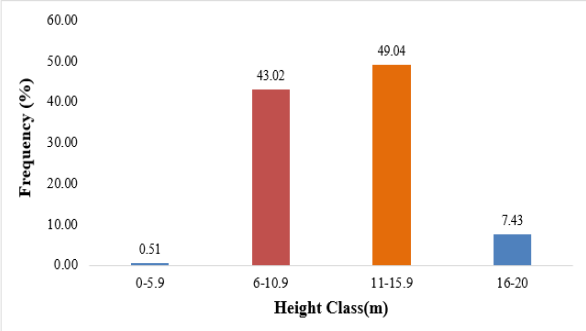

Fig. 3: Height Distribution class of Avenue Trees in FUNAAB

The result in Table 2 shows the various biodiversity indices of avenue trees in the study area. A total of 12 tree species were recorded in the study area, comprising 781 individual trees. The biodiversity indices calculated are as follows; Shannon-Wiener Diversity Index (H') = 0.92, Evenness (E) = 0.14, and Simpson's Diversity Index (D) = 0.4.

Table 2: Diversity indices of avenue tree species in the study area

Diversity	Avenue Tree Species
Number of species	12
Number of individuals	781
Simpson index (1-D)	0.40
Shannon-Wiener Diversity Index(H')	0.92
Evenness	0.14

Distribution of native and exotic avenue trees in FUNAAB

The study also shows that the percentage of exotic species (90%) to indigenous species (10%) among the avenue tree population in the study area is high as illustrated in the pie chart presented in Figure 4.

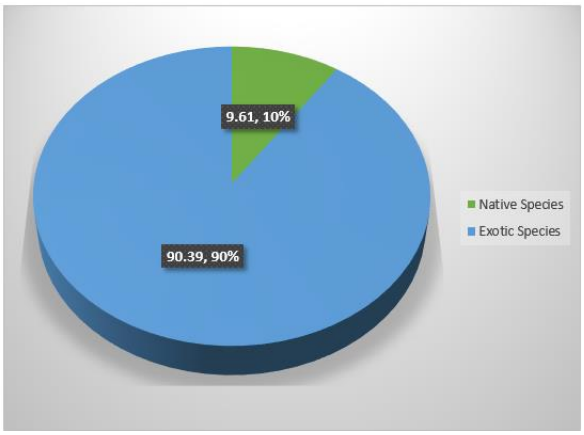

Fig. 4: Native and Exotic Tree Species Composition of Avenue Trees in FUNAAB.

DISCUSSION

The study revealed a dominance of exotic species over indigenous species among the avenue trees on campus. This pattern aligns with the observations of Onefeli *et al.* (2023), who also reported the predominance of exotic species in urban tree populations. While exotic species may offer rapid growth and ornamental advantages, overdependence on them may reduce ecological stability and limit the conservation of indigenous biodiversity within urban landscapes.

Among the exotic species identified in this study, *Gmelina arborea* (Melina) and *Albizia zygia* (Mpepe) were the most dominant. Their dominance suggests that these species are particularly suitable as avenue trees within the study area. This suitability is likely due to their broad and spreading canopies, which provide extensive shade and improve pedestrian comfort on campus (Wonder *et al.* 2017, Olugbadieye *et al.* 2019). The predominance of *Gmelina arborea* in this study location is consistent with earlier findings of Olokeogun *et al.* (2020), while Oyerinde *et al.* (2018) also identified the species as the dominant avenue trees in institutions across southwestern Nigeria. Its widespread occurrence has been linked to its effectiveness as a prolific seed source (Olokeogun *et al.* 2020).

Beyond the ornamental value, ecological and socio-economic benefits, the avenue tree species contribute significantly in other areas like provision of medicine. For instance, *Antidesma thwaitesianum* has been reported to be used for food and medicine (Thongmuang *et al.* 2024). In addition, previous studies have emphasized the importance of urban trees within the FUNAAB campus and the wider Abeokuta metropolis, Ogun State, Nigeria. Adekunle *et al*. (2008) observed that trees on the campus improve environmental quality by reducing urban heat, mitigating the effects of climate change, and enhancing the aesthetic quality of the environment for staff and students. Similarly, Dare *et al*. (2015) and Ogunlade *et al.* (2023) noted that residents of Abeokuta value urban trees mainly for ecological services, especially shade provision and environmental regulation, rather who noted that residents of Abeokuta place greater value on the ecological functions of urban trees, particularly their ability to provide shade and environmental benefits, rather than for tangible products such as firewood or food.

The diversity indices obtained from this study indicate that the avenue tree population is not well balanced. The Shannon-Wiener diversity index value of 0.92 is comparatively low, suggesting limited species richness and the dominance of only a few species within the campus landscape. When compared with findings from similar studies conducted in other Nigerian institutions and urban landscapes, the diversity level recorded for FUNAAB is considerably lower. For example, Oyerinde *et al.* (2018) reported diversity values of 1.97 and 2.50 for avenue trees in the Federal University of Technology Akure and Adekunle Ajasin University respectively. Likewise, Olokeogun *et al.* (2020) reported a value of 1.10 for avenue trees at The Polytechnic, Ibadan, Nigeria. Even higher diversity indices were documented by Agbelade *et al.* (2016) for urban trees in the Ibadan metropolis (3.35), Abuja (3.56) and Minna (3.08). These comparisons indicate that the tree population on the FUNAAB campus is less diverse than those in many other Nigerian urban environments. Such low diversity may increase vulnerability to pests, diseases, and environmental disturbances, as tree populations dominated by only a few species are generally less resilient (Keesing and Ostfeld 2024, Onefeli *et al.* 2023).

A similar trend was observed in the species evenness value obtained in this study. The evenness index of 0.14 indicates an uneven distribution of individuals among species, meaning that a small number of species account for most of the avenue tree population while many others are sparsely represented. This value is substantially lower than those reported in related studies. Oyerinde *et al.* (2018) recorded evenness values of 0.32 and 0.45 for FUTA and AAUA, respectively, while Olokeogun *et al.* (2020) reported a value of 0.34 for the Polytechnic, Ibadan. Similarly, Agbelade *et al.* (2016) reported a value of 0.84 for the Ibadan metropolis. Similarly, Aladesanmi *et al.* (2016) documented evenness values of 0.52 and 0.54 for Abuja and Minna, respectively. These findings further confirm that species distribution on the FUNAAB campus is highly uneven compared with other urban tree populations in Nigeria.

CONCLUSION AND RECOMMENDATIONS

This study examined the diversity and relative abundance of the avenue tree species within Federal University of Agriculture, Abeokuta campus. The findings revealed that the avenue tree population consisted of 12 species belonging to 8 families, with a total of 781 individual trees recorded across the study area. Also using the diameter class of 10-29.9cm and the height class of 11-15.9m recorded in the study area, indicates that most of the avenue trees on campus fall within the medium-sized growth category.

The diversity assessment showed relatively low species diversity within the avenue tree population. The Shannon-Weiner diversity index 0.92, while the species evenness value was 0.14, alongside a Simpson's diversity index of 0.40. These values indicate that the avenue tree population is dominated by on few species, mostly exotic species, with an uneven distribution of individuals among species. This may have negative implications for the ecological resilience of the avenue tree population, making it more vulnerable to pest infestations and disease outbreaks, which could threaten the long-term sustainability of the campus landscape. Therefore, future avenue tree planting projects in the study area should prioritize the introduction of diverse indigenous and adapted tree species to improve species richness and structural balance, and enhance the resilience and ecological value of the campus landscape.

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