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DIVERSITY OF TREE SPECIES IN KAFANCHAN AREA OF KADUNA STATE, NIGERIA

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ABSTRACT
This research assessed the diversity of trees in Kafanchan environs and investigated the perception of inhabitants to land use change and use of trees in Kafanchan environs, Kaduna State. Primary data on the field was collected by employing the plot count techniques by systematically and randomly selecting eleven plots within the study area, measuring a 100 by 100 meters plot (1.0 hectare) of each plot. All the trees species on the selected plots were enumerated. A total of 28 species were identified with 1851 number of individual of trees. *Newbouldia laevis* species had the highest number of stand (415) and a percentage composition of 22.4%. Family Aracaceae has the most count of species in the area while other families had a two and single species within the family. Species diversity, evenness and relative density were determined between plots for the identified trees. Shannon -Wiener diversity values (H) for the eleven plots were recorded for trees, Plot 10 had the highest diversity of 4.54 and Plot 5 with the least diversity of 0.703, the study recorded 1.56 as the highest diversity and 0.65 as the least diversity respectively.

Keywords: Diversity, Drainage pattern, Soil, Trees species, vegetation

INTRODUCTION

Land use has enormous effect on the hydrological balance and biodiversity through fragmentation of natural habit (Villamor *et. al.,* 2014; Tuner et al., 1995). According to Adeyinka (2012), Nigeria is rich with a variety of plant and animal species. There are about 7,895 plant species identified in 338 families and 2,215 genera (FGN: Fourth Biodiversity Convention, 2010). Among these animals, about 0.4% threatened while 0.22% endangered. All of these plant and animals species occur in different numbers within the country's vegetation that range from the mangrove along the coast in the south to the Sahel in the North. Although savannah tree species are not as valuable for timber as those found in rainforests, a few species commercially harvested. The savannah habitats support a good number of large mammals (examples, various antelopes, elephants, lions, among other, which are all found in savannahs elsewhere in Africa. These animals are increasingly scarce in Nigeria and nearly nonexistent in areas outside those few protected areas that actually receive protection (Hahn, 2013). These organisms generally threatened by human population growth and adverse land use changes. Out of the 7895 species recorded in 2010, back in 2001, the first National Biodiversity Report presented tree species endangered and almost extinct in the year report.

MATERIALS AND METHODS

STUDY AREA

Kafanchan is the headquarters of Jema'a Local Government Area of Kaduna (Figure 1). It has a geographical coordinates between latitude 9º33 '30" to 9º36 '30"North and longitude 8º 16' 0" to 8º 20' 0"East with an elevation of 739km (2,425 feet) and a time zone of WAT (UTC+1). It is a junction station of the Nigerian Railway Cooperation connecting Port-Harcourt, Enugu, Kuru, Bauchi and Maiduguri. It is located relative to Sabo in the North-east, Ungwan Madaki Northwards, Kwarabe and Gigira South-eastwards (Musa *et al.,* 2016).The five wards in Kafanchan include: Kafanchan A, Kafanchan B, Kaninkon, Maigizo and Takau.

CLIMATE AND TOPOGRAPHY

The Guinea Savannah vegetation type designated as Koppen's Aw climate has two distinct seasons, a wet season in summer and a dry season (Figure1); the major soil type is the Ferruginous tropical soil, which is related to the climate, vegetation, lithology and the topography of the area. The relief is relatively flat and undulating and it influences the drainage pattern of the area (Adaaje, 2015). Rainfall occurs between the months of April to October with a peak in August. The mean annual rainfall is about 1800 mm and the mean monthly temperature is 25ºC, while the relative humidity is about 63%. The orographic influences of the Jos-Plateau and the Kagoro Hills have affected the climate of the study area influencing rainfall, temperature and relative humidity (Ishaya & Abaje, 2008).

VEGETATION

The Guinea Savannah found in the middle belt of Nigeria and typified by open woodland with tall grasses and fire resistant trees. The derived savannah found further south, borders the remaining forest zone, and is continuing to spread south as more forestland degraded into agricultural uses. Desertification is also causing the borders of the drier savannah types to move southward (Hahn, 2013).

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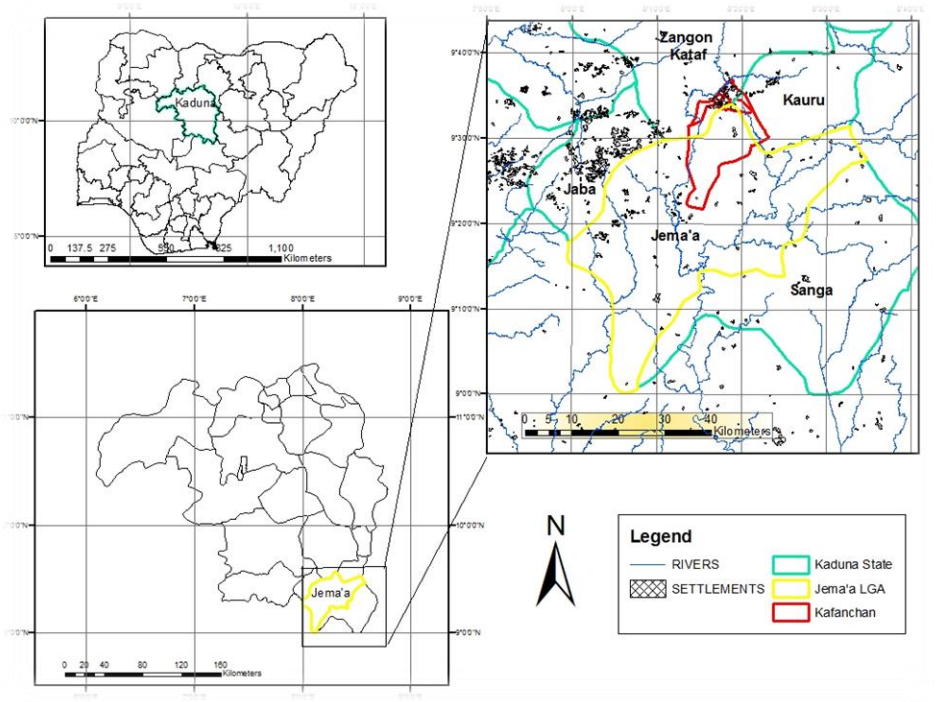

Figure 1: Map of Study Area
Source: Author 2023

RECONNAISANCE SURVEY

The study area visited and surveyed for familiarity; the researcher obtained coordinates for training areas to aid the land use/land cover classification using a hand held Global Positioning system (GPS) from the Department of Environmental Management. Each ward within the study area was visited and vegetation and land use characteristics observed.

SAMPLE SIZE AND SAMPLING TECHNIQUE

Questionnaire Administration

The stratified random sampling employed to determine the sample population. The target population consists of the various land users in the study area. The sample population was according to political wards. These political wards make-up the strata from which 6% of the total number of households for each ward sampled. The number of households as determined by Hassan (2018) was adopted (Table 1). A semi-structured questionnaire was administered to the respondents. The target population was set for household heads which were not available and the eldest in the various wards were sampled.

Table 1: Sample Distribution According To Wards

Political Wards	Number of Households	Number Sampled at 6%
Kafanchan A	542	33
Kafanchan B	385	23
Takau	820	49
Maigizo	1,116	67
Kaninkon	640	38
Total	3503	210

Source: Author's Analysis, 2023 (Adopted from Hassan, 2018).

VEGETATION STUDIES

The field studies were in the form of ground truthing and vegetation studies to identify the areas with abundant species diversity and those areas of rareness, this was facilitated by the use of measuring tape, ranging poles, hand GPS, chalk, quadrants and camera.

Systematic random sampling technique was adopted for plot location in the study area. The random sampling provides no subjectivity because samples are selected at random with each potential sampling unit having an equal chance of selection, completely independent of the selection of all other units (Husch *et. al.,* 1972). The study area was divided into two 100 × 100 m plots. The plot count technique also known as the modified Whitaker's technique was used (Whittaker, 1975). Representative plots of known sizes were mapped out using surveyors tape and ranging poles. The plots selected at random from a raffle draw with the aim of sampling 11% of the study area (a total of 11 km^2 from universe of 112 km^2). Eleven plots selected for the study. Living trees with diameter at breast height (dbh) > 10 cm and a height of >100cm on each field plot recorded by species. Species density from 15% and above in the plots is considered as abundant. All the trees species that fall within the mapped out plot were identified counted and recorded (Blench, 2017). The procedure was repeated for all the eleven plots. To compare the species affected especially, to examine the nature of tree species abundance and distribution. In the vegetation studies, the relative density calculated is in Oduwaiye *et al.,* (2003).

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

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Where: RD = relative density; n_i = number of individuals of species and N = total number of individual in the entire population.
Community diversity indices calculated from a mathematical formula, which account both species richness and relative abundance of each species in the community. The equation for the Shannon-Weaver diversity index (Price 1997) used was:

$$H' = -\sum_{i=1}^{S} P_i \ln P_i$$

Where H' = Shannon diversity index, S = total number of species in the community, Pi = relative density
Evenness (E) was calculated as described by Magurran (1988):

$$E = H'/\ln S$$

Tree species identification was done with the aid of tree identification guide books; A Hausa Botanical Vocabulary (Dalziel, 1916); Trees of Nigeria (Keay et al., 1964, 1989), Flora of West Tropical Africa (Hutchinson & Dalziel, 1958-1968); Hausa Names for Plants and Trees (Blench, 2007).

ASSOCIATION BETWEEN PLOTS

Magurran (2004) described the Jaccard's index for comparing communities to not only interest diversity of a single site, but compares biodiversity levels across sites. A precise measure of similarity between two samples can summarize the fraction of species they have in common.
Jaccard's index is the simplest of this, taking the following form between samples a and b:

$$J = \frac{S_c}{S_a + S_b + S_c}$$

Where J is Jaccard's Index, S_a and S_b are the numbers of species unique to samples a and b, respectively, and S_c is the number of species common to the two samples.

RESULTS AND DISCUSSION

VEGETATION STUDIES

Tree species found in the sampling site were recorded according to the plots (table .2). The value of Shannon-Wiener diversity index (H) usually found to fall between 1.5 and 3.5 and only rarely surpasses 4.5 (Magurran, 1988). The Shannon-Wiener diversity index result for the eleven plots fall between 0.7 and 4.5. 1833 trees were counted belonging to 21 families (table 2). A total of 38 species were identified with 1851 number of individual of trees. *Newbouldia laevis* species had the highest number of stand (415) and a percentage composition of 22.6%. Family Aracaceae has the most count of species in the area while other families had a two and single species within the family (table 2).

Table 2: Tree Species Composition of The Study Area

Family	Botanical Names	Common Name
Annonaceae	Annona muricatas	Soursop tree
	Polilathia longifolia	Masquerade tree
Anacardiaceae	Magnifera indica	Mango tree
Araliaceae	Cussonia barteri	Mama
Arecaceae	Borasus flabellifer	Deleb palm
	Caryota urens	Fishtail palm
	Cocus nucifera	Coconut tree
	Elaeis guinensis	Oil palm
	Raphia sudanica	Gwangwalaa
	Ravenala madagascariensis	Traveller's palm
	Roystonea regia	Royal palm
Bignonaceae	Newbouldia laevis	Aduruku or Newbouldia
Bombacaceae	Adansonia digitata	Monkey-bread tree or Kuka
	Eriodendron oientale	Kapok tree or Rimi
Cactaceae	Carnegiea gagantae	Giant Cactus
Caricaceae	Carica papaya	Pawpaw
Combretaceae	Termanalia mantaly	Umbrella tree
Fabaceae	Pakia biglobosa	Locust-bean tree
Leguminoseae	Acacia senegalensis	Acacia tree
	Albizia zygia	African walnut tree
Miliaceae	Azadirachta indica	Neem tree, jan yaro
Moraceae	Ficus polita	Durumi
Moringaceae	Moringa oliefera	Moringa, Drumstick tree, Horse-radish tree, zogale
Musaceae	Musa species	Banana or plantain
Myrtaceae	Psidium guajava	Guava
	Eucalyptus tereticornis	
Papionioideae	Pterocarpus mildbraedii	Oha tree, Kimirim
Rosaceae	Pyrus Linnaeus	Pear tree
Rutaceae	Citrus species	Orange tree
Sterculiaceae	Cola acuminate	Kola tree
Verbenaceae	Gmelina arboreal	Melina
	Tectona grandis	Bankok teak
Fabaceae		"N'tsein"
		"Bubwat"
		"Satelite tree"
		"River Mystery tree"
		"like durian"
		"Riparian"

Source: Field Survey, 2023.

Species with greater than 10% coverage include; *Elaeis guineensis* 10.75%, *Musa species* at 11.48%, *Tectona grandis* at 17.95% and *Newbouldia laevis* at 22.64%. *Carica papaya* (5.51%) and *Gmelina arboreal* (5.07%) follow as greater than 5% coverage of the study area. It is also important to point out *Magnifera indica* (4.09%) and *Polylathia longifolia* (3.66%) to be relatively important to others with lesser coverage (Table 3).

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Table 3: Frequency of Occurrence of Trees In Kafanchan

Botanical Names	Family	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	Total	Percentage (%)
Acacia senegalensis	Leguminoseae	0	0	3	2	1	0	0	18	0	0	0	24	1.31
Adansonia digitata	Bombacaceae	0	0	4	0	0	3	0	0	1	1	0	9	0.49
Albizia zygia	Leguminosaeae	0	0	0	0	0	0	0	1	0	0	3	4	0.22
Annona muricatas	Annonaceae	0	0	2	0	0	0	0	0	0	0	0	2	0.11
Azadirachta indica	Miliaceae	0	0	2	0	0	0	0	2	4	2	0	10	0.55
Borassus flabellifer	Arecaceae	5	5	2	0	1	9	4	1	6	4	0	37	2.02
Carica papaya	Caricaceae	11	4	10	11	3	0	0	4	40	18	0	101	5.51
Carnegiea gagantae	Cactaceae	0	0	0	3	0	0	0	0	0	0	0	3	0.16
Caryota urens	Arecaceae	0	0	3	0	0	0	0	2	0	0	0	5	0.27
Cocus nucifera	Arecaceae	0	0	6	1	0	0	0	11	1	0	0	18	0.98
Citrus sinensis	Rutaceae	2	0	5	2	3	8	0	11	1	1	0	33	1.80
Cola acuminate	Sterculiaceae	0	0	0	0	0	2	0	0	0	0	0	2	0.11
Cussonia barteri	Araliaceae	0	0	0	0	0	1	0	3	0	2	0	6	0.33
Elaeis guineensis	Arecaceae	14	6	3	4	4	53	4	17	42	11	39	197	10.75
Eriodendron oientale	Bombacaceae	0	0	0	1	0	0	1	0	0	0	0	5	0.27
Eucalyptus tereticornis	Myrtaceae	0	0	0	0	0	0	0	7	0	1	0	8	0.44
Ficus polita	Moraceae	0	0	7	0	0	0	0	0	0	2	0	9	0.49
Gmelina arboreal	Verbenaceae	0	26	2	0	2	10	16	14	4	7	12	93	5.07
Magnifera indica	Anacardiaceae	13	12	8	2	0	1	13	12	3	8	3	75	4.09
Moringa oleifera	Moringaceae	1	0	1	13	0	5	0	0	9	0	0	29	1.58
Musa species	Musaceae	10	26	18	12	12	15	54	28	21	21	0	217	11.84
Newbouldia laevis	Bignonaceae	53	2	35	43	1	254	0	0	5	19	3	415	22.64
Parkia biglobosa	Fabaceae	0	4	0	0	0	0	5	2	2	1	5	19	1.04
Polylathia longifolia	Annonaceae	2	0	8	2	0	0	0	41	14	0	0	67	3.66
Psidium Guajava	Myrtaceae	2	0	2	0	0	0	3	1	1	2	0	11	0.60
Pterocarpus mildbraedii	Papionioideae	0	0	0	0	0	2	0	0	10	0	0	12	0.65
Pyrus Linnaeus	Rosaceae	0	0	17	0	0	0	9	2	2	1	0	31	1.69
Raphia sudanica	Arecaceae	0	0	0	0	0	0	0	0	0	3	7	10	0.55
Ravenala madagascariensis	Arecaceae	0	0	0	0	0	0	0	2	0	0	0	2	0.11
Roystonea regia	Arecaceae	0	0	0	0	0	0	0	4	0	0	0	4	0.22
Tectona grandis	Verbenaceae	54	34	0	33	44	15	14	22	33	25	55	329	17.95

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Terminalia mantaly	Combretaceae	0	0	0	0	0	0	0	0	1	0	0	1	0.05
"N'tsein"	Fabaceae	0	0	0	0	0	1	0	0	2	0	0	3	0.16
"Bubwat"		0	0	0	0	0	0	0	0	0	3	0	3	0.16
"Satelite tree"		1	0	1	0	0	0	0	0	0	0	0	2	0.11
"River Mystery tree"		0	0	0	0	0	0	3	0	0	0	6	9	0.49
"like durian"		0	0	0	0	0	0	0	0	0	0	23	23	1.25
"Riparian"		0	7	0	0	0	0	0	0	0	0	0	7	0.38

Source: Field Survey, 2023.

CONSCIOUS PLANTING

At a mean of 1.24 and standard deviation of 0.43, 76.2% of the population accepted that planting a tree on their property is a conscious endeavor while 23.8% declined that it was no conscious effort. This amplifies the "august" use of domestic tree cultivation in the study area (Figure 2).

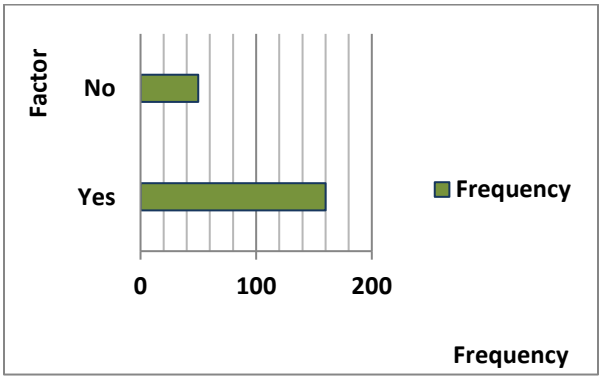

Figure 2: Respondents' Answer To Conscious Planting
Source: Author 2023

58.1% of population have oldest trees of >10 years, 14.8% of the population have oldest trees at 6-10 years, 7.1% of the population ratify the age of their oldest tree between 4-5 years, between <1 years old trees 3.8% of the population and 2-3 years old trees 3.3% in Table 4.

Table 4: Age of Oldest Tree on Property

Age of Oldest Tree	Frequency	Percent (%)
<1	8	3.8
2-3	7	3.3
4-5	15	7.1
6-10	31	14.8
>10	122	58.1
No tree	27	12.9
Total	**210**	**100.0**

Source: Field Survey, 2023.

COMMON TREES PLANTED IN NEIGHBOUROODS

From the mode of responses in Table 5, *Magnifera indica* is the most common tree planted in Kafanchan A (22), B (14) and Takau (24) Wards. *Tectona grandis* in Kaninkon Ward (26) and *Elaeis guineensis* in Maigizo Ward (37).

Table 5: Common Trees In Neighbouhoods

Common Name (Tribe)	Scientific Name	Frequency					MODE	TOTAL
		Kafanchan A	Kafanchan B	Kaninkon	Maigizo	Takau		
Palm tree	Elaeis guineensis	2	7	25	37	15	37	67
Teak	Tectona grandis	2	4	26	15	18	26	65
Aduruku (Hausa) Maduruku (Kaninkon)	Newbouldia laevis	1		16	1		16	18
Kwaara (Hausa)	Vitellaria paradoxa	2		2		3	3	7
Banana Ayaba (Hausa) Ayabar daajii (Hausa) Plantain	Musa spp	1	1	10	3	7	10	22
Mango Mangworo (Hausa)	Magnifera indica	22	14	10	26	24	26	116
Pear Madachi (Hausa)	Pyrus Linnaeus	7	6	6	13	17	17	49
African Mahogany (English)	Khaya senegalensis					1	1	1

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Orange	Citrus sinensis	7	6	5	19	21	21	49
Buab (Kaninkon) Bauree (Hausa) Forest Fig (English)	Ficus lutea			1			1	1
Malaina (Hausa)	Gmelina arboreal	4	3	3	7	4	7	21
Jan yaro	Hymenocardia acida							
Rimi	Eriodendron oientale							
Guava	Psidium Guajava	7	5	4	21	2	21	39
African locust bean tree	Parkia filicoidea Parkia biglobosa					8	8	8
Jagalandi (Hausa) Zoogale (Hausa) Horseradish tree (English)	Moringa oleifera	1	2	5	8	2	8	18
Cashew	Anacardium occidentale	2	2	1	7	2	7	14
Pawpaw Gwanda	Carica papaya	8	5	9	15	5	15	37
Neem (English) Doogon yaaroo or Dar bejiya (Hausa)	Azadirachta indica		1			1	1	2
Coconut tree (English) Attaagara (Hausa)	Cocus nucifera	4			1	4	4	9
Oha (Igbo) N'nem (Kaninkon)				1			1	1
Leemun Masar (Hausa)	Citrus medica	1	1		1		1	3
MODE		22	14	26	37	24	37	116
TOTAL		71	55	122	174	134		556
MISSEN								74

Source: Author's Analysis, 2023**.**

Dogo (2014) enunciated the destruction and complete harvesting of macro-flora as mahogany trees and all-log bearing trees that grow naturally, similarly, mahogany tree was admitted by one respondents to be a common tree (Takau ward; Madachi: *Khaya senegalensis*). Although the common tree planted in Kafanchan according to responses is *Magnifera indica*, *Newbouldea laevis* is the dominant tree in the vegetation studies carried out.

USES OF TREE SPECIES SELECTED

At a mean of 3.61 and standard deviation of 1.08, respondents accepted that trees planted for a source of fuel wood. With a mean of 4.31 and a standard deviation of 0.69, respondents accepted that trees are for edible fruits. The mean of responses (3.68) and a standard deviation of 1.18, reveal acceptance that trees are for lumber. With a mean of 3.95 and a standard deviation of 1.10, respondents confirm that trees are for medicinal purposes. With a mean of 3.75 and a standard deviation of 0.80, respondents culminated that trees are for landscaping and gardening **(**Figure 3**).** The mean of responses (3.38) and a standard deviation of 1.11, uncover concurrence that trees are for soil fertility improvement. The mean of responses (3.30) and a standard deviation of 1.07, reveal acceptance that trees are for fodder.

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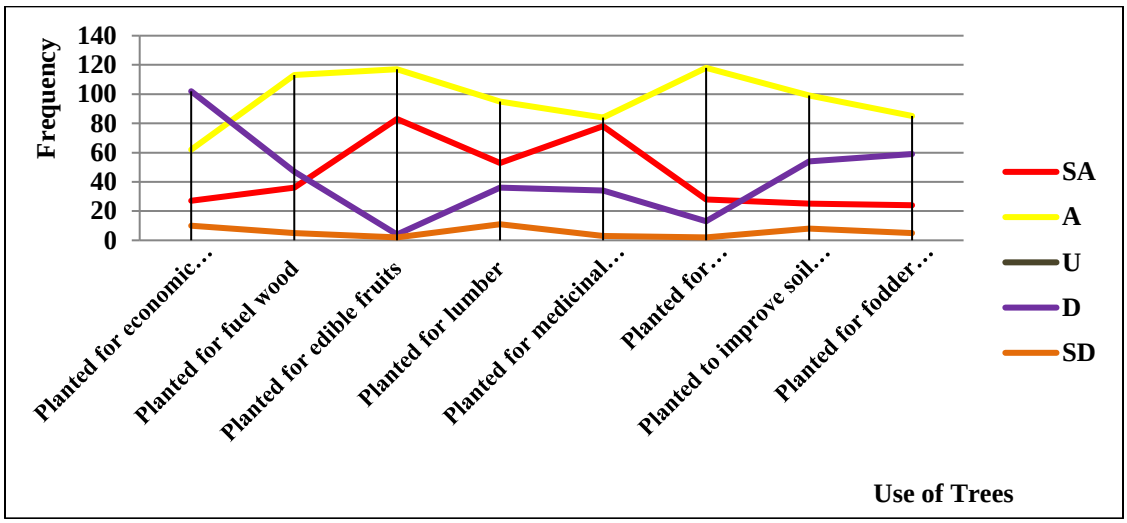

Figure 3: Uses of Tree Species Selected
Source: Author's Analysis, 2023.

Common Trees Planted in Neighbourhoods

The value of Shannon-Wiener diversity index (H) usually found to fall between 1.5 and 3.5 and only rarely surpasses 4.5 (Magurran, 1988). Iment and Adebobola (2001) posited that biodiversity indices generate the diversity and abundance of species in different habitats to similar scale for comparison and the higher the value, the greater the species richness The Shannon-Wiener diversity index result for the eleven plots fall between 0.7 and 4.5. 1833 trees were counted belonging to 21 families. Agbelade *et. al.,* (2016) in their study obtained results of Shannon- Wiener diversity index (H') for Minna to be 3.08 and Abuja at 3.56. Adekunle *et. al.,* (2013) obtained Shannon-Weiner index (H') for Ala (Ondo State) and Omo (Ogun State) to be 3.66 and 3.34 respectively, a value less than the vale obtained in Kafanchan. Ogwu *et. al*., (2016) while studying the tree species diversity and distribution in the University of Benin solved a Shannon-Weiner index (H') of 0.86; much lesser than the value obtained in Kafanchan. Adaaja *et. al.,* (2015) recorded a Shannon-Wiener diversity index (H') of 5.7 at Gurara forest, which is higher than the index value obtained in Kafanchan. A total of 38 species were identified with 1833 number of individual of trees. *Newbouldia laevis* species had the highest number of stand (415) and a percentage composition of 22.6%.Family Aracaceae has the most count of species in the area while other families had a two and single species within the family.

The responses of respondents, *Elaeis guineensis* is the most common tree in Kafanchan, results from the vegetation study points *Newbouldea laevis,* this a par with Al –amin's (2014) study of urban vegetation in Kaduna metropolis, *Magnifera indica* was found to be the dominant tree species in the area. Since varying morphological characteristics of the woody plants make some of them more suitable to provide certain values to the local communities (Read & Lam 2001; Radha *et. al, 2013*) some woody plant species are more important. Agaba *et. al.,* (2015) are of the opinion that local people appreciate species like *Magnifera indica,* with the highest overall use value, for fruit, fodder, firewood, medicine and shade. Although 75 species of *Magnifera indica* was counted in the vegetation studies, *Magnifera indica* is the most common tree planted in Kafanchan A (22), B (14) and Takau (24) Wards. *Tectona grandis* in Kaninkon Ward (26) and *Elaeis guineensis* in Maigizo Ward (37) from the view of the respondents.

Uses of Trees Selected

Rana, (2010) poised that wives among the Luo community of western Kenya have rights of collection and use of fruits, but are restricted from harvesting fuel wood of high value timber trees. Among the Akamba community of eastern Kenya, women have enjoyed use and access rights to fodder, fuel wood, fiber, fruits and mulch. As it relates to the results, trees are not solely planted for economic reasons (53.4%); trees are planted for, fuel wood, edible fruits, lumber, medicinal purposes, shade and gardening, for fodder, and to improve soil fertility. According to FAO Report (2018) on Forests and Sustainable Cities, evidence of urban food forests can motivate stewardship practices and provide opportunities for interact with nature and society (McLain *et al.,* 2012); food forests enable the development of more resilient food systems and promote social and environmental sustainability (Yates, 2014); encourage social cohesion and healthiness and fortify local communities (Lwasa *et. al*., 2015); improve biodiversity (Dennis & James, 2016); and contribute economic benefits for both municipalities and citizens (Lafontaine-Messier *et. al*., 2016).

Conclusion

Newbouldia laevis species had the highest number of stands (415) and a percentage composition of 22.6%. Family Aracaceae has the most count of species in the area while other families had a two and single species within the family. Species diversity, evenness and relative density were determined between plots for the identified trees. Shannon -Wiener diversity values (H) for the eleven plots was recorded for trees, Plot 10 had the highest diversity of 3.282 with Evenness of 0.617 while Plot 5 with the least diversity of 0.703 and Evenness of 0.165 and Plot 5 with the least diversity of 0.703. Although from the responses of respondents, *Elaeis guineensis* is the commonest tree in Kafanchan, results from the vegetation study points *Newbouldea laevis.* Other common trees found include *Musa species*, *Polylathia longifolia*, and *Tectona grandis.* The Jaccard index reveal no significant difference in the association of tree species between vegetation land use class and other land use classes.

They posited factors such as origin, growing and unconcerned

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population, intensification of agricultural activities, gender and culture, and urban development respectively to be dominant factors that affect tree species selection and diversity. Results from survey carried out support these findings, although there are variations as to the dominant families and tree species. The results obtained in Kafanchan identifies *Newbouldia laevis* as the dominant tree species. It is amicable that the disparity of the area coverage characteristic is the subject of this difference, as human habitations use *Newbouldia laevis* as hedges and green fences.

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