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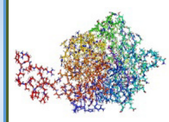

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Vegetation Structure and Diversity in Northern Yobe, Nigeria

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ABSTRACT

The study examined the diversity of vegetation (tree species and shrubs) for the preservation, utilization and conservation of tree species in Northern Yobe. A point centred quarter (PCQ) method was employed to study the vegetation structure in six randomly selected experimental sites across the three local government councils in Northern Yobe (Yunusari, Yusufari and Geidam). A total of 22 tree species and 7 shrubs belonging to 15 families were identified, with Fabaceae being the family with the highest number of tree species (5 members), and followed by Combretaceae, Mimosaceae, and Rhamnaceae each with 3 members. Aracaceae, Euphorbiaceae, Rhamnaceae, and Moraceae have 2 members each, while other identified families had a member of tree species. Specifically, Sodom apple was the dominant tree species based on Importance Value Indices (IVI) of 23.3, followed by Doum palm (22.0), then Guiera tree and Combretum species, each with IVI of 20.7, followed by Desert date (20.3), Thorn Acacia (19.9), and then Whistling thorn (19.3 as their IVI. The Diversity index was determined as 1, Simpson's index of diversity was very low (-0.0082) and the species richness was 0.41. The low values indicate a less complex community, and the distribution pattern of the various parameters assesses was that of a typical Sahel-Savannah vegetation. Nevertheless, there was a large number of different tree species (29) recorded which implies many tree species are adaptable in the study area but only regenerated naturally without effort for intensive production. Therefore, the need of mass production of these trees in plantation and agroforestry for the conservation and utilization of the dominant (most adapted) tree species to halt environmental associated problems including desertification and erosion in the study area.

INTRODUCTION

Vegetation (trees and shrubs) provide different benefits which ecological benefits (e.g., shelterbelt, control of soil erosion, watershed management, control of desertification, mitigation of climatic change), source of livelihood or socio-economic benefits (e.g., income from sales of woods, fuelwood, fruits, and other non-timber forest products) and cultural values such as spiritual, and aesthetic values. The estimated plant species in Nigeria were about 7,895 distributed across 338 taxonomical families and 2,215 genera [1–6]. However, most of these plant species are threatened due to the extension of the farm as a result of increasing farming activities from rising population, desertification, urbanization, logging and fuelwood harvesting [7]. According to Naibbi [8], about 60 – 80% of the population in Africa largely depend on plants for their food and livelihood, and nearly 60% of the population in Nigeria relied on fuelwood as their main source of energy for cooking and heating [7]. In Northern Nigeria alone, more than 80% of the population depend on fuelwood as their primary cooking and heating fuel. With the continuing growing population, and high human poverty index [9], it is expected that these figures will continue to rise [10–12].

The vegetation type of Yobe state is mainly savannah, climatically defined into Northern Sahel savannah and Sudan savannah [13]. The vegetation is characterised by shrubs and trees and grasses. The trees are short by about 5m-10m. The vegetation cover is being altered largely by human activities impacting some parts of the Sudan savannah to taking the features of a typical Sahel region characterized by aridity and desertification [13]. These are also being influenced by excessive firewood collection, overgrazing, land clearing for agriculture

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and bush burning. Therefore, only when the composition of the vegetation is known, a holistic management and conservation efforts can be made toward the effective management of the vegetation resources in Northern Nigeria. However, information is the diversity of the vegetation in Northern Yobe is scarce [14]. The tree and shrubs thought to be abundant might actually be threatened or vulnerable species [15]. Many plants and animals' resources globally are currently at risk of extinction or being threatened, and most importantly, natural processes such as pollination by insects and the recycling of soils by microorganisms and the survival of the microorganisms, people and their resources are generally affected. For instance, the world's forests are diminishing rapidly and each year about 294,020 square kilometres of forest disappear [6].

Vegetation is such a vital component of the ecosystem whose productive, protective and recreational functions have been recognized [16]. Vegetation, specifically woody trees and shrubs help to control soil erosion, stabilize regional and global climates; provide carbon sinks, and neutralize air pollution. The extent to which trees and shrubs, are exploited regardless of the vegetation zone of an area calls for immediate attention of all stakeholders [7,8]. Different countries continue to explore different ways of managing the ecosystem, For example, Amadi et al. [17] suggest remedial and corrective anti-desertification measures in Nigeria that include the incorporation of indigenous desert control knowledge into government environmental conservation programmes e.g., massive and sustained tree planting exercise using adaptable tree species such as *Azadiratchta indica* and Jatropha that are capable of stabilizing and fixing sand, as well as introduction and implementation of legislation against tree felling, encouraging the use of kerosene stoves, irrigation and discouragement of bush burning.

Therefore, this is a study aimed to document the composition of tree species and shrubs and analyze the soil in relation to its roles in supporting the dominant species in North-east Yobe, Nigeria. This is important for management and conservation purpose. The purpose of this study is to profile the vegetation richness and composition (relative density, relative frequency, relative abundance, value index) of the tree species of the study area and to observe the production and/or regeneration method of the tree species adapted to the study area

Conceptual Framework

According to Imenda, [18] a conceptual framework is an end result of bringing together many related concepts to explain or predict an event or provide a broader description and explanation of an interesting event or research problem. This study hypothesized that understanding vegetation structure, diversity or composition in Northern Yobe will attract the attention of policy and decision-makers as well as other stakeholders in finding ways of controlling desertification in the area of study, halting erosion, enriching biodiversity, reducing pressure on natural forests due to reliance of fuelwood by the population, sustaining the forested areas, conserve the environment, providing a livelihood for the population, and creating micro-environment that can favour the survival of organisms including human in the area of study.

This study strives to address the knowledge gap of the diversity of trees and shrubs in Northern Yobe by undertaking a field activity that quantifies trees and shrubs species as well as observing the methods of production of the trees and shrubs, and whether or not there is existing evidence of planting and managing trees and shrubs that are adapted to the study area in the form of plantation management, shelterbelt, agroforestry and the likes as a strategy for improving the diversity of trees and shrubs and controlling menace such as desertification.

MATERIALS AND METHODS

Study Area

Location of the Study

The study is carried out in Yobe state which is located in North-eastern Nigeria. Yobe has 17 local government councils. The total land area of Yobe is 4,660,900 ha (46,609 km^2) from which 386,710 ha constitute the area covered by forest reserves. Moreover, the total population in Yobe is 2,321,339 comprising 1,171,931 of males and 1,122,869 females. Yobe State is characterized by two types of vegetation (Sudan Savannah and Sahel Savannah). The local government councils within the Savannah vegetation are located in the Southern part of Yobe, and most of the local governments within the Sahel Savannah region of Yobe are located in the northern parts of Yobe [19]. The Sudan Savannah part of Yobe (Southern Yobe) has denser vegetation, higher annual rainfall (713 mm), and a longer period of precipitation (four months) while the northern part of the state is characterized by open vegetation and shorter trees of about 5 m and grasses while receiving an annual average rainfall of 275 mm for a period of three months. Yobe state has distinct dry and wet seasons, with the dry season extending from October to June, and the wet season beginning in May and ending in September. In terms of the mean annual temperature, 35ºC was reported in Yobe [19].

The Study area comprised three local government areas in Northern Yobe (Yusufari, Geidam and Yunusari,). Yusufari is in Latitude 13° 15' 14" N and Longitude 10° 55' 41" E; Geidam is located in Latitude 12° 55' 0" N and Longitude 11° 55' 0" E; while Yunusari is Latitude 13° 6' 16" N and Longitude 11° 47' 11" E [20]. Two areas as study sites were randomly selected from each local government for this study including Bulanguwa, Bulatura, Degeltura, Kanama, Yusufari and Yunusari (**Fig. 1**). Most of the inhabitants are Peasant farmers, pastoralists, and grocery owners. These three local government councils among others located in the Northern Yobe match the category of Sparse Woodland with Herbaceous layers, shrubs and emergent based on one of the recognized classifications of vegetation [21]. **Fig. 2** below summarises the conceptual framework of this study that focuses on the diversity of the vegetation (tree species and shrubs).

Method of Data collection

The study uses multiple methodologies ranging from field activity (identification of the trees and shrubs (vegetation), and Observation of production//regeneration methods. The combined methods were aim for the purpose of triangulation to help identify the causal-effect relationship between the diversity of tree species and silvicultural practices in the study area. The study follows previous studies on vegetation that also used combined methodologies [7,8,22].

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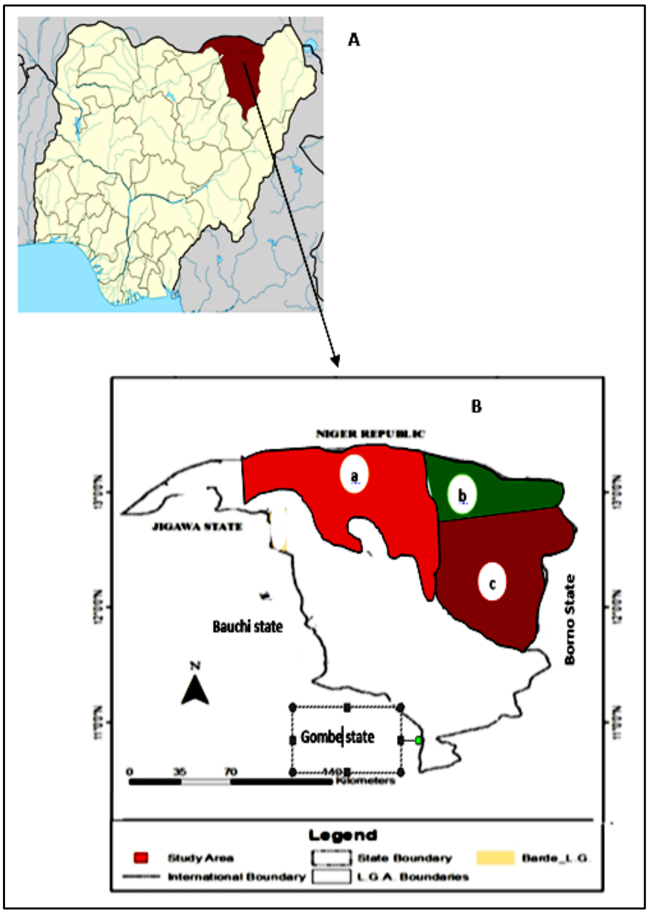

Fig. 1. Map of Nigeria Showing the location and the study areas: **A** (Map of Nigeria showing Yobe); **B** (Map of Yobe sampled local government councils); **a**: Yusufari; **b:** Yunusari**; c:** Geidam.

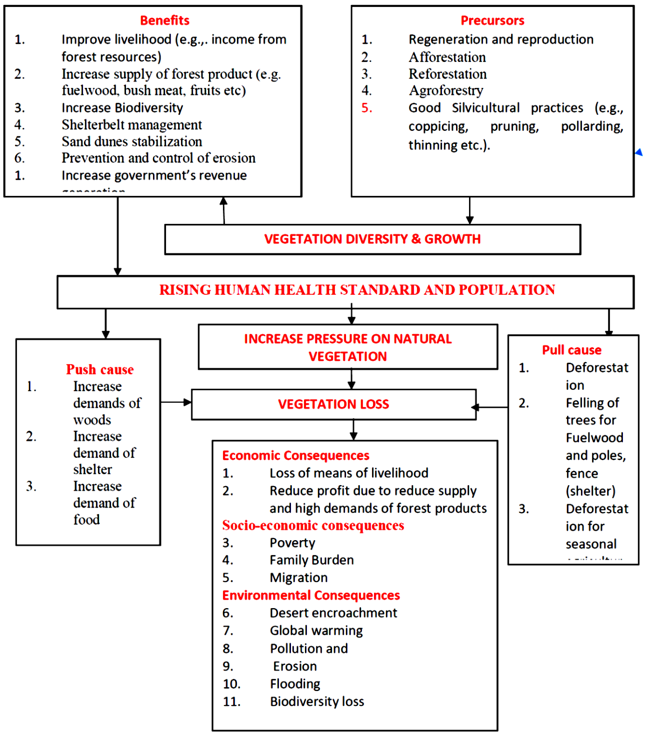

Fig. 2. Conceptual framework of the study.

Profiling of vegetation characteristics

Vegetation cover sampling procedures

The data of the study was collected through field activities. Stratified random sampling using point centred quarter (PCQ) method was used (**Fig. 3**). Sampling for diversity and abundance was carried out randomly in the six different study sites across the three local government areas. The plant species shrubs and trees are present in the study areas. The point-centered quarter method procedure of vegetation estimation was used in data collection as described by Zhigila, et al. [6], who also followed a previous study [23].

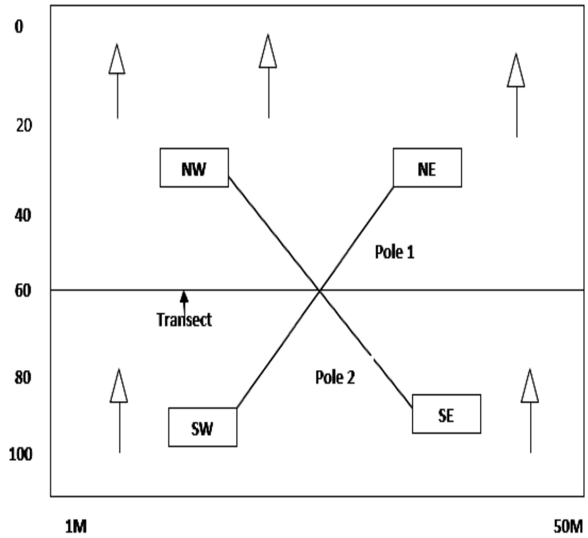

Fig. 3. Point-centered quarter sampling method.

Collection and Identification of Tree Species

The Tree species were identified using a guided taxonomic key, field guides and floras and texts containing coloured photographs [7,24]. All unidentified plant samples were collected from the study areas, which were then flattened out on flimsies and pressed between the absorbents under heavy pressure immediately after collection at the field. The plants were packaged with ventilators in the plant press for drying in the oven. The dried plants were then separated and properly identified using the herbarium specimens of Federal College of Education (Technical) Potiskum, Yobe state. In terms of the proportion of plant species surveyed, a species-effort curve. The species effort curve was used, which showed the cumulative number of plant species per section of the six different sites from three locations. The data on the characteristics of vegetation in the study was collected in six weeks from six sampled units across three randomly selected locations in Northern Yobe of Nigeria.

Observation

The method of regeneration and reproduction of the vegetation in the six study sites was observed. Additionally, the presence or absence of plantation and agroforestry in the study area were also observed and reported

Method of Data Analysis

Both descriptive and parametric statistical tools were employed in analyzing the data. The quantitative data obtained on Relative density, Relative frequency, relative abundance and Importance value index were calculated following a previous study [25]. Therefore, the Density was calculated by the equation:

$$\frac{Total\ number\ of\ individuals\ of\ a\ species\ in\ all\ quadrats}{Total\ number\ of\ quadrats\ studied}$$

$$Relative\ \frac{Number\ of\ indvidual\ of\ one\ species}{Total\ number\ of\ all\ individual\ counted}\ X\ 100$$

$$\frac{Number\ of\ quadrats\ in\ which\ the\ species\ occured}{Total\ number\ of\ quadrats\ sampled}$$

$$\frac{Frequency\ of\ one\ species}{Total\ Frequency\ of\ all\ species}\ X\ 100$$

$$\frac{Totla\ number\ of\ individuals\ of\ a\ species\ in\ all\ quadrats}{Total\ number\ of\ quadrats\ in\ which\ the\ species\ occured}$$

$$\frac{The\ abundance\ of\ one\ species}{Total\ number\ of\ all\ species\ counted}\ X\ 100$$

Importance Value Index = Relative Frequency + Relative Density + Relative Abundance Species diversity index was calculated using Simpson's index as follows:

$$D = \sum \quad (nnNN)^2$$

$$D = \sum \quad (\frac{n}{N})^2$$

Where:
D = diversity index
N = Total number of organisms of all species found
n = number of individuals of a particular species
The value of D, ranges between 0 and 1. With this index, Zero (0) represents infinite diversity and one (1) represents no diversity.
Species Richness = $D = S/\sqrt{N}$

Where:
D = the Menhinick's index;
S = the number of different species represented in the sample and
N = the total number of species in the sample.

The important quantitative analysis such as density, frequency, and abundance of tree species, shrubs and herbs species were determined as per Curtis and McIntosh [25]. Furthermore, general linear model analysis (ANOVA) will be used to compare the species richness of the six sites studied.

RESULTS

Occurrence, Diversity and Dominance of Vegetation in the Study Area

Results obtained from this study identified twenty-nine (29) species of tree and shrubs cutting across fifteen (15) families (**Table** 1). In terms of life forms, twenty-two (22) of the identified species were trees while seven (7) of the identified plants were shrubs (**Table** 1). The family Fabaceae recorded the highest frequency (5) and percentage frequency of 11 and 17.2% respectively, and Rhamnaceae, Euphorbiaceae, Arecaceae and Moraceae were represented with two (2) species (6.9%) each, while Anonnaceae, Anocarceae, Apocynaceae, Arecoideae, Ebenaceae, Maliceae, Malvaceae, Rubiacea and Zygophyllaceae, have the lowest number of representation with each recording one (1) and 3.44% frequency and percentage frequency each respectively (**Table 1**). **Table 2** shows about four thousand, eight hundred and eighty-nine (4,889) trees and shrubs inhabited the three study areas in northern Yobe. *Calatropis procera (*sodom apple*)* recorded the highest frequency among the tree species and shrubs with a total number of 1007, followed by *Acacia nilotica* (Thorn acacia) *with a* record of 569 frequencies. *Guiera senegalensis (Guiera tree)* recorded 392 species (**Table 2**). *Hyphaene thebaica* (Doum palm) had about 383 total species across the three study areas. *Combretum glutinosum (*Combretum tree*) had 374, Balanites aegyptiaca (*Desert date*) had a total of 291* species*, and Acacia seyel (*Whistling thorn*)* had about *258 species* (**Table** 2). The *least represented species were the Ficus syscomorus (*Ficus tree), *and Mitragyna inermis (*False abura) having *18* species *each, followed by Ficus thonningii (*Strangler Figs) *(17* species*.), Croton amabilis (*Croton Tree) *(16* species*.), Ziziphus spina-christi* **(**Christ's thorn**)** *15* species*. Adamsonia digitate (*Baobab tree*) (12* species*.), and Boswellia dalzielii (*Commiphora) *with 11* species (**Table 2**).

Table 1. The diversity and dominance (most adaptable tree species) vegetation in the study area.

English Name	*Botanical Names*	Common Name	Family	Life form
African birch	*Anogeissus leiocarpus*	Markie	Combretaceae	Tree
African mesquite	*Prosopis africana*	Kira	Mimosaceae	Tree
Baobab	*Adamsonia digitata*	Kuka	Malvaceae	Tree
Camel's foot,	*Piliostigma recticulatum*	Kargo	Fabaceae	Tree
Christ's thorn	*Ziziphus spina-christi*	Kurna	Rhamnaceae	Tree
Commiphora	*Boswellia dalzielii*	Arrarrabi	Burseraceae	Tree
Croton Tree	*Croton amabilis*	Moromoro	Euphorbiaceae	Tree
Date palm	*Phoenix dactylifera*	Dabino	Aracaceae	Tree
Desert date	*Balanites aegyptiaca*	Ádúúwàà	Zygophyllaceae	Tree
Doum palm	Hyphaene thebaica	Goruba	Arecaceae	Tree
Thorn Acacia	*Acacia nilotica*	Bagaruwa	Fabaceae	Tree
False abura	*Mitragyna inermis*	Giyayya	Rubiaceae	Shrub
Ficus tree	*Ficus syscomorus*	Bauree	Moraceae	Tree
Gum Arabic/	Acacia senegal	Dakwara	Mimosaceae	Tree
Indian plum	*Ziziphus mauritiana*	Magarya	Rhamnaceae	Tree
Marula	*Sclerocarya birrea*	Danya	Anacardiaceae	Tree
Guiera	*Guiera senegalensis*	Sàábáràà	Combretaceae	Shrub
Neem Tree	*Azadarichta indica*	Dogon-Yaro/Darbejiya/Maina	Maliaceae	Tree
Strangler Figs	*Ficus thonningii*	Céédííyáá	Moraceae	Tree
Tamarind	*Tamarindus indica*	Tsáámííyáá	Fabaceae	Tree
West African ebony	*Diospyros mespiliformis*	Kányà	Ebanaceae	Tree
Whistling thorn	*Acacia seyel*	Farar kaya	Mimosaceae	Tree
Wild cassia	*Cassia singuena*	Runhu/Runfuu	Fabaceae	Shrub
Wild custard apple	*Annona senegalensis*	Gwandàn dáji	Anonnaceae	Shrub
Winter thorn	*Faidherbia albida*	Gààwóó	Fabaceae	Tree
Black honey shrub	*Phyllanthus reticulatus*	Kalunbo	*Euphorbiaceae (Phyllanthaceae)*	Shrub
Silver Butterfly tree	*Bauhinia rufescens*	Matsagi	Fabaceae	Tree
Sodom apple	*Calatropis procera*	Tumfafiya	*Apocynaceae*	Shrub
Combretum spp.	*Combretum glutinosum*	Kattakara	*Combretaceae*	Shrub

Table 2. The occurrence of trees and shrubs species across the six studied sites in Northern Yobe.

Scientific Names	Site 1 (GDM)	Site 2 (GDM)	Site 3 (YUN)	Site 4 (YUN)	Site 5 (YUS)	Site 6 (YUS)	Total	Mean
Anogeissus leiocarpus	21	34	18	10	12	9	104	17
Prosopis africana	9	6	11	8	9	13	56	9
Adamsonia digitata	1	1	2	1	3	4	12	2
Piliostigma recticulatum	43	49	30	55	36	37	250	42
Ziziphus spina-christi,	1	1	2	3	3	6	16	3
Boswellia dalzielii	1	2	2	2	2	2	11	2
Croton amabilis	1	2	4	3	4	2	16	3
Phoenix dactylifera	6	6	1	1	2	5	21	4
Balanites aegyptiaca	11	34	45	56	67	78	291	49
Hyphaene thebaica	179	101	34	44	11	14	383	34
Acacia nilotica	104	178	35	66	88	98	569	95
Mitragyna inermis	2	3	3	4	4	2	18	3
Ficus syscomorus	1	2	3	4	4	4	18	3
Acacia senegal	4	8	9	8	8	8	45	8
Ziziphus mauritiana	22	43	22	38	45	34	204	34
Sclerocarya birrea	30	33	18	47	45	43	216	36
Guiera senegalensis	41	42	56	76	87	90	392	65
Azadarichta indica	33	32	18	15	18	23	139	23
Ficus thonningii	2	4	2	3	3	3	17	3
Tamarindus indica	5	6	7	7	8	8	41	7
Diospyros mespiliformis	3	4	4	1	4	3	19	3
Acacia seyel	34	55	67	24	34	44	258	43
Cassia singuena	7	7	8	9	9	9	50	8
Annona senegalensis	2	4	1	5	3	3	18	3
Faidherbia albida	24	45	23	27	29	34	182	30
Phyllanthus reticulatus	11	19	21	29	25	27	132	22
Bauhinia rufescens	12	8	18	7	7	18	70	12
Calatropis procera	208	204	100	109	199	187	1007	168
Combretum glutinosum	77	67	45	48	91	46	374	62
Total	895	1000	569	711	860	854	4889	
Mean	31	34	20	45	30	29		

Species Diversity

The Diversity index was determined as 1, Simpson's index of diversity was very low (-0.0082) and the species richness was 0.41. The alpha (within-site) diversity for the six sites is shown in **Table 3**. The Simpson's index of diversity (1-D) was -0.008 and the species richness was 0.4 (**Table** 3). The values indicated a less complex community because the entire three (3) communities were dominated by a few species (29 trees and shrubs). Thus, considered less diverse and does not allow for species interactions, which can further be described as low system stability.

Table 3. Importance value index (IVI) and diversity of trees and shrubs in Northern Yobe, Nigeria.

Scientific Names	Relative frequency	Relative density	Relative Abundance	IVI	Diversity Index (D)
Anogeissus leiocarpus	1.4	0.5	0.4	2.3	0.0212722438
Prosopis africana	2.1	0.7	1.9	4.7	0.0114542851
Adamsonia digitata	1.5	0.3	0.5	2.3	0.0024544896
Piliostigma recticulatum	4.7	6.7	5.7	17.1	0.0511352014
Ziziphus spina-christi	2.6	0.6	0.5	3.7	0.0032726528
Boswellia dalzielii	2.2	0.2	0.3	2.7	0.0022499488
Croton amabilis	2.1	0.4	0.3	2.8	0.0032726528
Phoenix dactylifera	2.2	0.3	0.4	2.9	0.0042953569
Balanites aegyptiaca	5.2	6.4	8.7	20.3	0.0595213745
Hyphaene thebaica	5.5	7.7	8.8	22.0	0.0783391286
Acacia nilotica	5.1	6.9	7.9	19.9	0.1163837185
Mitragyna inermis	1..3	0.4	0.7	2.4	0.0036817345
Ficus syscomorus	1.1	0.3	0.2	1.6	0.0036817345
Acacia senegal	1.6	0.5	0.7	2.8	0.0092043362
Ziziphus mauritiana	4.3	0.4	0.6	5.3	0.0417263244
Sclerocarya birrea	4.2	4.6	7.9	16.7	0.0441810814
Guiera senegalensis	4.4	8.5	7.8	20.7	0.0801799959
Azadarichta indica	3.3	8.5	8.5	20.3	0.0284311720
Ficus thonningii	1.5	0.6	0.5	2.6	0.0034771937
Tamarindus indica	2.3	0.4	0.5	3,2	0.0083861730
Diospyros mespiliformis	1.5	0.8	0.9	3.2	0.0038862753
Acacia seyel	4.9	6.7	7.4	19.3	0.0527715279
Cassia singuena	2.5	0.3	0.2	3.0	0.0102270402
Annona senegalensis	2.5	0.6	0.5	3.6	0.0036817345
Faidherbia albida	5.7	6.6	4.9	17.2	0.0372264266
Phyllanthus reticulatus (Sebania dalzielii)	3.1	7.9	6.5	17.5	0.0269993863
Bauhinia rufescens	6.6	7.0	5.0	18.6	0.0143178564
Calatropis procera	6.7	8.3	8.3	23.3	0.2059725915
Combretum glutinosum	7.9	6.9	5..9	20.7	0.0764982614
Total	100	100	100	302.7	1.0081818994
Samson's index of index		= 1 – D	= -301.7		-0.0082
Species richness		= $S/\sqrt{N}$	=29/√4889		0.4147515132

Note: D =1.008 =1 and represent no diversity

Table 4 shows the results of the general linear model that indicated a significant difference in plant species diversity. In the six different study sites. Specifically, site 6 had the highest species diversity while Site 2 had the least.

Table 4. Comparing plant species diversity across the six study sites – Mode (diversity – site 1 + site 2 + sites 3 + site 4 + sites 5 + site 6), N = 6, Adjusted R = 0.89.

	ANOVA values			Parameters estimate values				
	DoF	F value	P value		Estimate	SE	F-value	P-value
Intercept					-2.4	10.0	-2.3	0.03
Sites	5	5.5	0.001	Site 1	2.5	1.0	19.0	<0.001
				Site 2	-6	2.0	-4	<0.002
				Site 3	-4.1	3.2	-01	0.9
				Site 4	4.7	3.0	2.0	0.1
				Site 5	4.0	3.1	1.5	0.9
				Site 6	5.1	3.2	1.6	0.2

P-values in **bold** are significant. Diversity is set at zero based on alphabetical order and represents the intercept

The production method of the trees and shrubs in the study area

The results on the method of production of tree species in the six study sites showed that only *Azadarichta indica (*neem tree) was planted on large scale for the purpose of shelterbelt even though there were selected and that such tree species were planted for shade provision. In other words, other identified tree species and shrubs regenerated naturally in the study areas. Additionally, there was no evidence of wood lot, plantation and agroforestry programs in the study areas.

DISCUSSION

The study indicates that the Northern Yobe inhabit a few numbers of tree species and shrubs cutting across fifteen families. Therefore, the type of tree species and the total number of families of tree species recorded in this study were lower than that reported by Wakawa et al. [14], who also assessed tree species composition in the northern state of Kano, the differences could be attributed to the sampling intensity and the variation in ecological zones as northern Yobe state is entirely Sahel against the Sudan Savannah and Northern Guinea Savannah vegetation of Kano State. This is confirmed by Ali et al. [7] who stated that Vegetation cover varies from one ecological region to region and is also influenced by the amount of precipitation. Interestingly, the type of tree species identified in this study, as well as the family were higher than those identified by Bello et al. [2] in another state in Northern Nigeria (Katsina State) that is characterised by similar climatic conditions to Kano State. Our finding also confirms that Fabaceae and Combretaceae are families known to be native species in most savannahs [6]. Sahel Savannah region is expected to have few numbers of tree species, however, the level of tree planting campaign exercises carried out previously in the study area could be responsible for the identified 29 species of trees and herbs. Furthermore, effective enforcement of deforestation rules and patrol for the prevention of felling of woody trees for fuelwood as well as awareness of the importance of trees and impact of desertification and deforestation might have helped to allow the growth of different tree species in the study area. This confirms the report which suggested literacy is a factor responsible for effective management of tree species [8].

Calatropis procera (sodom apple), *Acacia nilotica* (Thorn Acacia), *Guiera senegalensis* (Guiera), *Hyphaene thebaica* (Doum palm), *Combretum glutinosum* (Combretum), *Balanites aegyptiaca* (Desert date), (291), and *Acacia seyel* (Whistling thorn) (258) accounts for more than 70% of the total tree and shrubs in the Northern Yobe. This is not surprising because these species often regenerated naturally as favoured by the wind and animal dispersal methods of their seeds, while *Hyphaene thebaica* species is known as an income-generating tree species relied on by rural population in Northern Nigeria, therefore, highly protected and conserved. The parts of *Hyphaene thebaica* is well known for it used in Northern Nigeria. For example, the trunk is used as poles for poles and roofing material, the leaves are used for local fans, woven baskets and mats, and the fruits are used for medicine and food. The results further show that with the exceptions of Fabaceae, other families were poorly represented, which concurred with the observation made by Ikyaagba et al. [15] and Nodza et al. [9]. The implication of this result means a possible danger for the member species of the poorly represented families as the species belonging to those families are threatened and can go to extinction in the near future [15]. Thus, the urgent need for holistic awareness of production and effective management of the tree species that fall within the poorly represented families.

The values that represented the Simpson's index of diversity (-0.008) and the species richness (0.4) determined in the study indicated a less complex community. A less diverse community do not allow for species interactions due to its low system stability, and poor environmental conditions [6]. The low diversity could also be due to the low rainfall and poor soil characteristics of the Sahel. Furthermore, the absence of evidence of the presence of wood lot, plantation and agroforestry programs for specific tree species in the study areas may be associated with a lack of policy or failure of its implementation in the study areas. Additionally, the non-production of tree species in the study area on a sustainable basis may also be explained by the characteristics climatic factor of the study area being a desert-prone area with a low amount of annual rainfall that is obtained within three months only. Therefore, the need for government and stakeholders to supply seedlings of trees and shrubs that can adapt to the harsh environment as observed in the case of *Azadarichta indica (*neem tree) that were successfully planted on large scale for shelterbelt in the study areas.

The vegetation composition of Northern Yobe can be described by the presence of a few dominant tree species that comprise Sodom apple, Doum palm, Guiera tree, Combretum tree, Desert date, Thorn Acacia, and Whistling thorn. Moreover, the twenty-nine (29) different trees and shrubs recorded across the six study sites in the three communities implies low vegetation composition and the absence of a program for intensive production of tree species such as agroforestry. The results of this study can be significant to policymakers, conservationists, and research institutions. The findings will be significant to policymakers as baseline data on the type of tree species' seedlings that can be produced to halt desert encroachment, which in turn support the sustainable development goals (SDGs) initiative of the United Nations especially SDG 13 and SDG 15 that focuses on climate Action and Life on land respectively [26].

The results of this study will guide policy and decision-makers in supporting the agroforestry program, afforestation, reforestation and shelterbelt development in the study. The result will be used by conservationists to improve, protect, and conserve biodiversity and related resources on lands owned by private, cooperative, partnership, and public local agencies. The study will serve as additional literature on vegetation structure, composition, diversity, and adaptation. The study was a step in that direction having focused on the composition, diversity and richness or rarity of tree species in Northern Yobe. Moreover, floristic studies are integral to biodiversity anywhere in the world and to put the region in focus for the local and global conservation efforts that it deserves. The results of the study will be useful in the development plan for the management of desert-prone areas as well as the conservation of fauna and flora associated with the area of study. Therefore, Government should initiate programs that promote the farming of forest trees (agroforestry) and the involvement of farmers in all activities of management of trees for desertification control, watershed management, and shelterbelt within their domain. This study only focused on the vegetation structures and diversity in Northern Nigeria using Yobe as a case study. Therefore, a study on the adaptability of the identified tree species to the soil in the study area should be carried out.

CONCLUSION

Sodom apple, Doum palm, Guiera tree, Combretum tree, Desert date, Thorn Acacia, and Whistling thorn dominate Northern Yobe's vegetation. The Diversity index = 1, Simpson's index of diversity = -0.008, and species richness = 0.41, indicating a less complex Sahel-Savannah Vegetation community. Twenty-nine (29) distinct trees and shrubs recorded across six study locations in three villages suggests poor vegetation composition and the absence of an agroforestry program. Policymakers, conservationists, and research institutions can benefit from this work. The findings will be important to policymakers as baseline data on the type of tree seedlings that can be produced to stop desert encroachment, which supports the sustainable development goals (SDGs) initiative of the United Nations, especially SDG 13 and SDG 15 that focuses on climate Action and Life on land respectively. The study's conclusions will be used to manage desert-prone areas and conserve local animals and flora. The government should promote agroforestry and involve farmers in all tree management operations for desertification control, watershed management, and shelterbelts. This study focused on Northern Nigeria's vegetation forms and diversity in Yobe. Soil adaptation of identified tree species should be studied in future studies.

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