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Woody species composition and growth form in Lema Forest Reserve, Arewa Local Government, Kebbi State, Nigeria

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ABSTRACT

Rapid increase in population around Lema Forest Reserve has led to increasing pressure on floral resources which affected their composition and growth form. This study assessed the composition and growth form of woody species in Lema Forest Reserve using transect and quadrat methods. A total of 50 quadrats (20m×20m) were laid along 5 transects of 2 km length. All woody species encountered within the quadrats were identified and enumerated and their height and DBH measured. Frequency, density, dominance, basal area and importance value index (IVI) of each species were also calculated. A total of 195 stems belonging to 28 species and 14 families were identified and recorded. The dominant species were *Bauhinia thonningii*, *Cassia sieberiana and Combretum ghasalense*, while the dominant families were Fabaceae and Combretaceae. The results show that the stems are generally of medium to low height, with *Adansonia digitata*, *Ficus polita*, *Khaya senegalensis* and *Vitex doniana* having the highest mean height. Similarly, 57% of the stems have a diameter of above 70 cm, indicating that they are generally mature and big. However, tree density in the reserve is low (390/ha^{-1}) due to anthropogenic pressure in the form of selective logging for fuelwood, browsing by animals and extraction of medicinal plants. There is thus the need for collaborative efforts for conserving the reserve.

Keywords: Woody Species; composition; structural characteristics

INTRODUCTION

The term vegetation is used in ecology to describe the overall characteristics of plant cover in an area by referring to dominant plant growth forms or structural characteristics. It is usually described by its floristic (species) composition and structural characteristics (Abdullahi, 2010; Adejuwon, 2007; Areola, 2012; Rajiv, 2017; Savadogo, 2007). Plant community comprises of different species of plants with different life-forms (trees, shrubs, forbs and grasses). The most abundant species in any plant community which also exercise the greatest influence on the habitat are referred to as the dominant species while other species are secondary (Demise, 2006). In the tropics for example, it is difficult to identify a dominant

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species because of the multiplicity of species. But where man modified the vegetation, one or few species may become dominant, example *Combretum micranthum* (Geza), *Guera senegalensis* (Sabara) and *Bauhinia thonningii* (Kalgo) found in northern parts of Kebbi State, especially in Arewa Local Government.

Vegetation cover in any area depends partly on the physical environment. The factors which influence plants growth and distribution include climate, soils and relief (Abdullahi, 2013; Areola, 2012). other factors relate to the interaction between the plants themselves and animals (biotic factors) and activities of man (anthropogenic factors) (Muhammad, 2014; Naibi, 2014; Ogunleye, 2004; Ritter, 2011;). The characteristics and distribution of vegetation on a global scale are determined more by climatic factors than by any other factor (Burrows, 1990; Ellison, 2017) but at local level, factors such as rocks, soils, relief, drainage, and human activities play great roles in determining nature and distribution of vegetation (Audu,2013). These factors do not act independently of one another; they interact to influence vegetation (Dhameja, 2008).

Knowledge of the composition and structure of woody vegetation is important for understanding the ecological attributes of forests, which show variations in response to environmental as well as anthropogenic activities which to a certain extent determine their ability to produce adequate and qualitative goods and services necessary for human survival and economic development (Jibrillah, 2019; Markus, 2015). This study therefore assessed the composition and growth form of woody species in Lema Forest Reserve.

METHODOLOGY

The Study Area

The study area is Lema Forest Reserve. It is located between latitude 12º 57'N and 13º 16'N and longitude 4º 08'E and 4º 20'E with total land area of 593.19km² and estimated population of 17,950 people, (NPC, 2006). The climate of the area is tropical continental, essentially semi-arid in nature, with high temperature throughout the year and marked wet and dry seasons. The wet season starts from May and ends September. Rainfall in the area is generally convectional in nature. Mean annual rainfall ranges between 500-1500mm, with the heaviest amount received in the month of August. The dry season lasts for almost eight months and is accompanied by hot, dry and dusty wind.

Vegetation of the area is typical Sudan Savannah type, characterized by open woodlands, short grasses, stunted scrubs, shrubs and trees. Local variation occurred from hilly and low-lying areas in the reserve due to difference in topography, different soil properties and degree of human influence on floral resources. The plants are generally xerophytes, which have generally adapted to the long dry season by shedding their leaves during dry season to prevent excessive loss of water through transpiration and lying dormant during periods of long drought. The appearance of vegetation in the area changes with season; it appears green and fresh during rainy season but turns yellow-brown and patches during dry season (Figure 1).

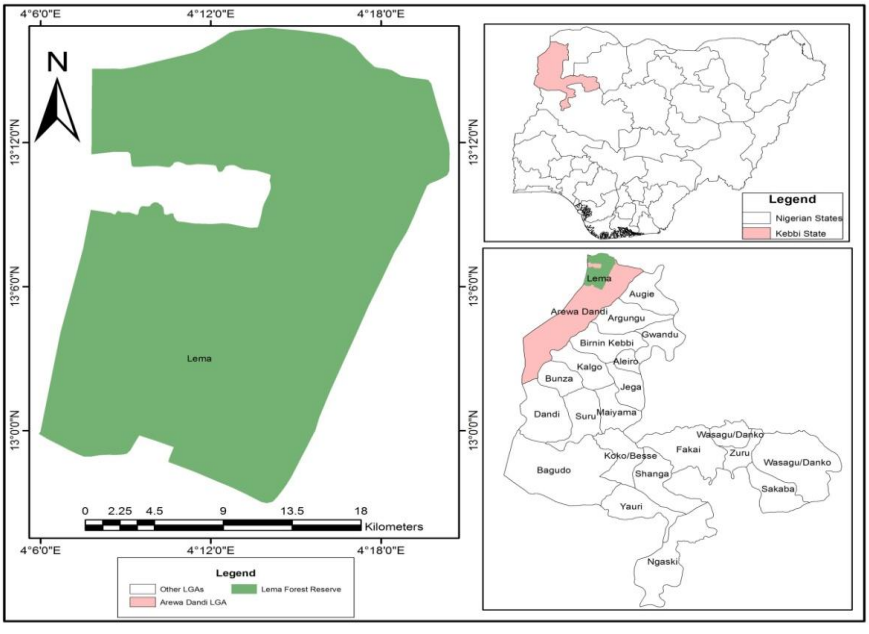

Figure 1: Lema Forest Reserve

Materials and Methods

Woody species composition and their growth form in the reserve were assessed using transect and quadrat methods. A total of 5 transects, of 2km length were laid across the forest reserve at 200m intervals. The choice of the length and interval of transect is informed by the size of the area and sparseness of the vegetation (Dangulla, 2013; Markos, 2015; Rajiv, 2017). Along each transect, a total of 5 quadrats of 20m×20m dimension were alternately laid;thus, giving a total of 50 quadrats. All woody species encountered in the quadrats were identified and enumerated with the help of field assistants.

The frequency distribution of woody species was calculated by grouping the species into five (5) classes; Class A (01-20%), Class B (21-40%), Class C (41-60%), Class D (61-80%) and Class E (81-100%) based on their percentage of occurrence (Demise, 2006; Dangulla, 2013). Information on the structural characteristics of the woody species such as the species frequency, density and structure were also measured and calculated. Species structure was determined by analyzing their vertical, horizontal and quantitative structure (Dangulla et al., 2014; Kershaw, 1973). Vertical structure was obtained by measuring trees' height using Haga's Altimeter. Species were categorized into three height classes as obtained from Dangulla, 2013 and Rajiv, 2017; Upadhaya, 2004. Mean height of more than 15 meters was considered as higher class, 8m-15m was considered as middle class while less than or equal to 8 meters was considered as lower class. The horizontal structure was obtained by measuring trees' diameter at breast height (1.3m/130cm above ground level) using a diameter tape while the quantitative structure was obtained by calculating species density per hectare (Dangulla, 2013; Markos, 2015).

RESULTS AND DISCUSSION

Floristic Composition

A total of 195 stems belonging to 28 species and 14 families were identified and enumerated in the reserve. The composition of woody species in the reserve shows six species; *Bauhinia thonningii, Cassia sieberiana, Combretum ghasalense, Guera senegalensis, Parkia biglobosa and Sclerocarya birrea* accounting for 54% of the stems in the reserve while the remaining 22 species account for 46%. This indicates a relatively heterogeneous type of vegetation across the reserve (Table 1).

Table 1: Floristic composition of woody species in Lema Forest Reserve

S/N	Species	Family	Hausa Name	Total Stems	Frequency (%)
1	*Acacia nilotica*	Fabaceae	Bagaruwa	08	4.10
2	*Acacia sieberiana*	Fabaceae	Farar kaya	06	3.08
3	*Adonsonia digitata*	Malvaceae	Kuka	03	1.54
4	*Albizia chevalieri*	Fabaceae	Katsari	01	0.51
5	*Anogeissus leiocarpus*	Combretaceae	Marke	01	0.51
6	*Balanites aegyptiaca*	Balanitaceae	Aduwa	07	3.59
7	*Bauhinia thonningii*	Fabaceae	Kalgo	32	16.41
8	*Cadaba farinose*	Capparaceae	Gawasa	02	1.02
9	*Calotropis procera*	Apocynaceae	Tunfafiya	01	0.51
10	*Cassia sieberiana*	Fabaceae	Malga	27	13.85
11	*Combretum ghasalense*	Combretaceae	Taramniya	12	6.15
12	*Combretum micranthum*	Combretaceae	Geza	03	1.54
13	*Combretum nigricans*	Combretaceae	Tsiriri	09	4.62
14	*Detarium microcarpum*	Fabaceae	Taura	04	2.05
15	*Diospyros mesipiliformis*	Ebenaceae	Kanya	05	2.56
16	*Faidherbia albida*	Fabaceae	Gawo	06	3.08
17	*Ficus polita*	Moraceae	Durumi	01	0.51
18	*Ficus thoningii*	Moraceae	Chediya	01	0.51
19	*Gardenia erubescens*	Rubiaceae	Gaude	03	1.54
20	*Guera senegalensis*	Combretaceae	Sabara	14	7.18
21	*Khaya senegalensis*	Meliaceae	Madacci	01	0.51
22	*Mimosa pigra*	Fabaceae	Gumbi	04	2.05
23	*Parkia biglobosa*	Fabaceae	Dorawa	11	5.64
24	*Prosopis Africana*	Fabaceae	Kirya	09	4.62
25	*Sclerocarya birrea*	Anacardiaceae	Loda	10	5.13
26	*Vitellaria paradoxa*	Sapotaceae	Kade	04	2.05
27	*Vitex doniana*	Lamiaceae	Dinya	04	2.05
28	*Ziziphus mauritiana*	Rhamnaceae	Magarya	06	3.08
			Total	195	100

The frequency distribution of species in the reserve shows that many species such as *Ficus polita, Ficus thonningii, Cadaba farinose, Khaya senegalensis* were rarely found as they were represented by very few stems. However, *Bauhinia thonningii* has the highest frequency (16.1%) and therefore considered more frequent in the reserve. This is followed by *Cassia sieberiana* (13.9%), *Guera senegalensis* (7.2), *Parkia biglobosa* (5.6%) while *Combretum nigricans* and *Prosopis africana each* obtained a frequency of 4.6%.

Species and Family Dominance

A total of seven woody species were found to be dominant in Lema Forest Reserve, with *B. thonningii* being the most dominant. This species has the highest importance value of 35.65, followed by *Cassia sieberiana* with total importance value of 31.28, *A. digitata* (18.50), *P. biglobosa* (17.23), *P. africana* (16.22), *C. ghasalense* (15.98) and *Guera senegalensis* with importance value of 15.30. The dominance of these species was attributed to their physiological adaptation to climate and soil in the area (Table 2).

Table 2: Species importance value index (IVI)

S/N	Species	Total Stand	RF	RD	RBA	IVI
1	*Acacia nilotica*	08	4.10	4.10	1.32	9.52
2	*Acacia sieberiana*	06	3.08	2.05	1.78	7.93
3	*Adonsonia digitata*	03	1.54	3.08	15.42	18.50
4	*Albizia chevalieri*	01	0.51	1.54	3.53	4.56
5	*Anogeissus leiocarpus*	01	0.51	0.51	6.28	7.31
6	*Balanites aegyptiaca*	07	3.59	0.51	2.73	9.91
7	*Bauhinia thonningii*	32	16.41	3.59	2.83	35.65
8	*Cadaba farinose*	02	1.02	2.05	1.15	3.20
9	*Calotropis procera*	01	0.51	0.51	0.27	1.30
10	*Cassia sieberiana*	27	13.85	1.03	3.59	31.28
11	*Combretum ghasalense*	12	6.15	13.85	3.67	15.98
12	*Combretum micranthum*	03	1.54	6.15	0.42	3.50
13	*Combretum nigricans*	09	4.62	16.41	1.23	10.46
14	*Detarium microcarpum*	04	2.05	1.54	5.75	9.85
15	*Diospyros mesipiliformis*	05	2.56	4.62	1.78	6.91
16	*Faidherbia albida*	06	3.08	2.05	3.93	10.08
17	*Ficus polita*	01	0.51	2.56	4.58	5.61
18	*Ficus thoningii*	01	0.51	0.51	5.77	6.80
19	*Gardenia erubescens*	03	1.54	0.51	0.39	3.46
20	*Guera senegalensis*	14	7.18	1.54	0.94	15.30
21	*Khaya senegalensis*	01	0.51	7.18	2.33	3.35
22	*Mimosa pigra*	04	2.05	3.08	0.27	4.3
23	*Parkia biglobosa*	11	5.64	0.51	5.95	17.23
24	*Prosopis africana*	09	4.62	5.64	6.99	16.22
25	*Sclerocarya birrea*	10	5.13	4.62	3.36	13.61
26	*Vitellaria paradoxa*	04	2.05	5.13	8.83	12.94
27	*Vitex doniana*	04	2.05	2.05	3.99	8.09
28	*Ziziphus mauritiana*	06	3.08	3.08	0.91	7.06
Total		195	100.00	100.00	100.00	300

RF = Relative Frequency: RD = Relative Density: RBA = Relative Basal Area: IVI = Importance Value Index: SD: Species Dominance

Family frequency and dominance of woody species in the reserve (Table 3) show that the family *Fabaceae* has the highest frequency (108) and considered to be the most dominant family, followed by *Combretaceae* with family dominance values of 52.55 and 39%

frequency. The least families in terms of dominance values are *Apocynaceae* (1.3), *Caparaceae* (3.2), *Meliaceae* (3.35) and *Rubiaceae* (3.46).

Table 3: Family frequency and dominance of woody species

S/N	Family	Family Frequency (%)	Family Dominance
1	Fabaceae	108	146.69
2	Combretaceae	39	52.55
3	Malvaceae	3	18.5
4	Anacardiaceae	10	13.61
5	Sapotaceae	4	12.94
6	Moraceae	2	12.41
7	Balanitaceae	7	9.91
8	Lamiaceae	4	8.09
9	Rhamnaceae	6	7.06
10	Ebenaceae	5	6.91
11	Rubiaceae	3	3.46
12	Meliaceae	1	3.35
13	Capparaceae	2	3.2
14	Apocynaceae	1	1.3
Total		195	300

Growth form of Woody species

Analysis of the vertical structure of woody species in Lema Forest Reserve revealed that *A. digitata* has the highest mean height of 38.5m, followed by *F. polita* (32m), *K. senegalensi*s (29m) and *V. doniana* (27m). Species with the least mean height on the other hand, include *C. farinose* (8.2m), *G. erubescens* (8.5m) and *C. procera* (9m) (Figure 1).

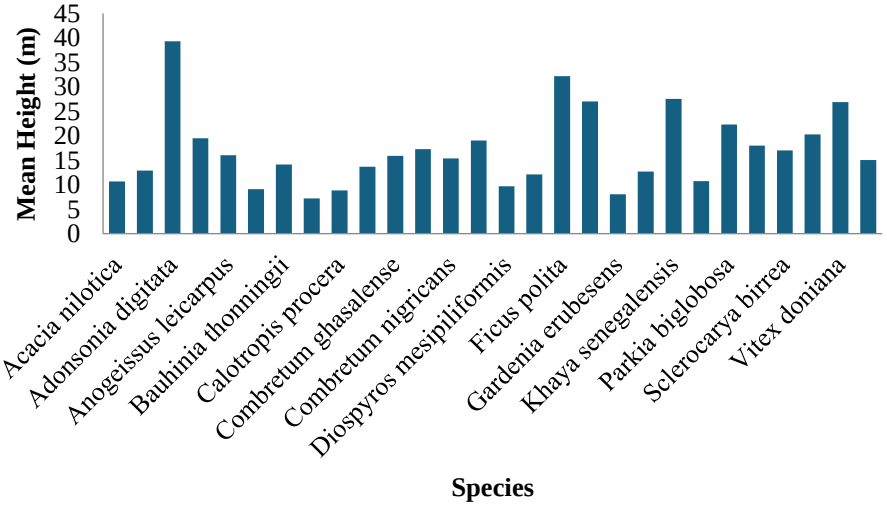

Figure 1: Mean height of woody species

The result further revealed that 50% of the stems belongs to the higher height class (≥15m), 46% belongs to the middle class (8m-15m) while only 4% belongs to the lower class (<8m). The latter group are smaller and juvenile trees that are yet to reach the maturity stage of development. This as a whole shows normal J-curve, contrary to what was obtained by Dangulla (2013) and Rajiv, (2016). The availability of higher height woody trees shows there is still existence of full-grown mature trees in many parts of the reserve. While the presence of medium height trees was attributed to trees lopping for animals and selective exploitation of fuel wood in the reserve (Figure 2).

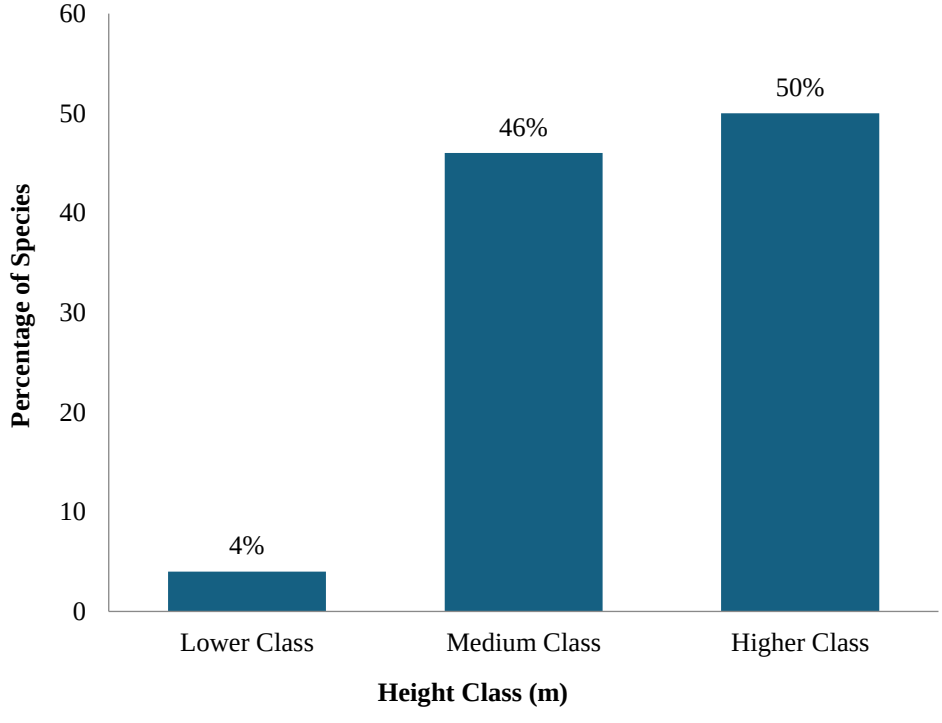

Figure 2: Height classification of woody species in Lema Forest Reserve

Analysis of the horizontal structure of woody species in the reserve revealed that *B. thonningii* has the highest total Diameter at Breast Height (DBH) of 300.48cm and total basal area of 2644.04cm^2. Therefore, it is considered the species with most outstanding horizontal structure in the reserve and followed by *C. sieberiana* with total DBH of 290cm and total basal area of 2828.02cm^2 and *P. biglobosa* with total DBH of 159.47cm and total basal area of 2361.36cm^2. Woody species with the lowest total DBH values in the reserve include *C. procera* (3.18cm) and total basal area of 7.96cm^2, followed by *K. senegalensis* with total DBH values of 9.29cm and total basal area of 31.43cm^2 (Figures 3 and 4).

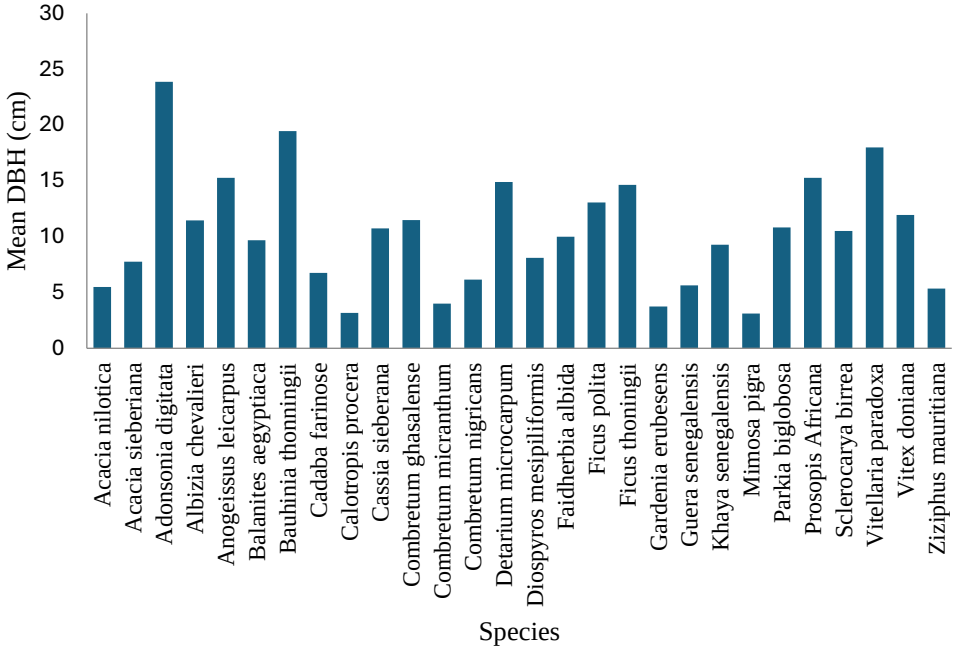

Figure 3: Species mean diameter at breast height

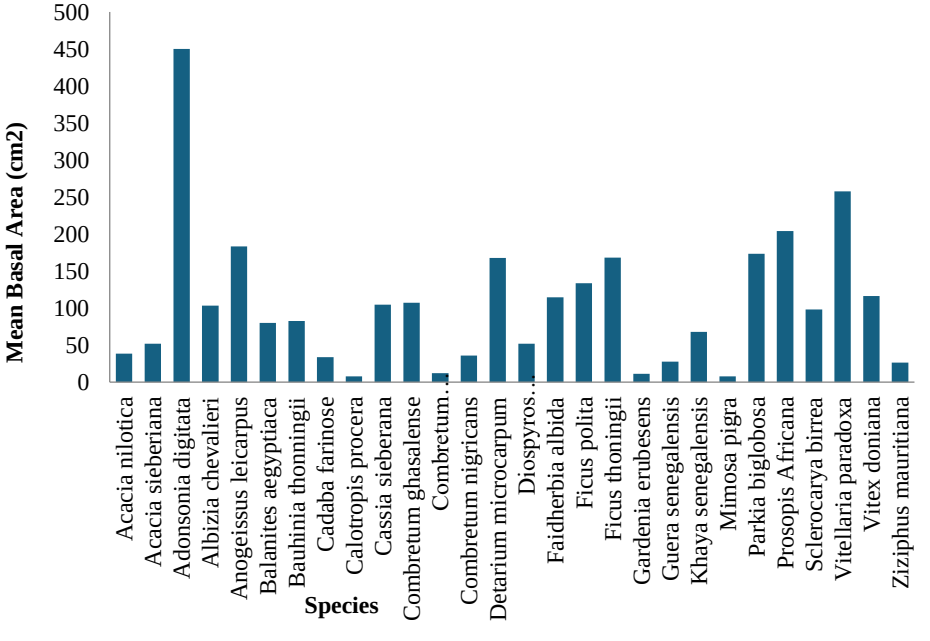

Figure 4: Mean basal area of woody species in Lema Forest Reserve

The analysis further revealed that 57% of the woody species in Lema Forest Reserve have a diameter above 70cm, this indicates that the trees in the reserve are matured and big. Similarly, 11% of the species belong to 31-40 diameter class and 4% belongs to 61-70cm diameter classes. No species was found within 41-50 diameter class in the reserve (Figure 5).

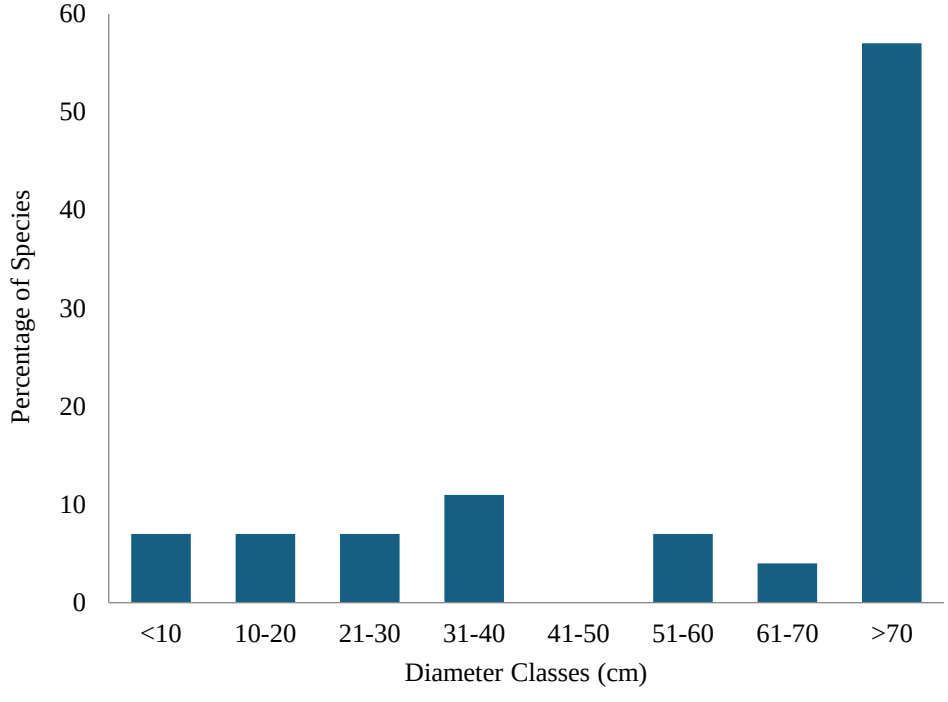

Figure 5: Diameter distribution of woody species in Lema Forest Reserve

The overall density of the species in the reserve is 390/ha^{-1} (Table 4). This value generally shows the sparsity (low density) of woody species in the reserve. However, *Bauhinia thonningii* has the highest per hectare density of 64/ha^{-1} followed by *Cassia sieberiana* (54/ha^{-1}), *Guera senegalensis* (28/ha^{-1}), *Combretum ghasalense* (24/ha^{-1}), *Parkia biglobosa* (22/ha^{-1}), and *Sclerocarya birrea* (20/ha^{-1}). Species with the least density per hectare include *Albizia chevalieri, Anogeissus leiocarpus, Calatropis procera, Ficus polita, Ficus thonningii* and *Khaya senegalensis* with density of 2/ha^{-1} each. As confirmed by Worku et al. (2023), the sparse density of most species in the reserve could be explained by anthropogenic pressure in the form of selective logging for fuelwood, browsing by animals and extraction of medicinal plants which results to fewer saplings, shrubs and trees. This also leads to decreased richness and diversity of threatened, endemic, and native species (Bisht et al., 2022).

Table 4: Per hectare stand density of woody species in Lema Forest Reserve

S/N	Species	Local Name	Family	Species Density per Hectare		
				Total	D Ha^{-1}	RD
1	*Acacia nilotica*	Bagaruwa	Fabaceae	8	16	4.1
2	*Acacia sieberiana*	Farar kaya	Fabaceae	6	12	2.05
3	*Adonsonia digitata*	Kuka	Malvaceae	3	6	3.08
4	*Albizia chevalieri*	Katsari	Fabaceae	1	2	1.54
5	*Anogeissus leiocarpus*	Marke	Combretaceae	1	2	0.51
6	*Balanites aegyptiaca*	Aduwa	Balanitaceae	7	14	0.51
7	*Bauhinia thonningii*	Kalgo	Fabaceae	32	64	3.59
8	*Cadaba farinose*	Gawasa	Capparaceae	2	4	2.05
9	*Calotropis procera*	Tunfafiya	Apocynaceae	1	2	0.51
10	*Cassia sieberiana*	Malga	Fabaceae	27	54	1.03
11	*Combretum ghasalense*	Taramniya	Combretaceae	12	24	13.9
12	*Combretum micranthum*	Geza	Combretaceae	3	6	6.15
13	*Combretum nigricans*	Tsiriri	Combretaceae	9	18	16.4
14	*Detarium microcarpum*	Taura	Fabaceae	4	8	1.54
15	*Diospyros mesipiliformis*	Kanya	Ebenaceae	5	10	4.62
16	*Faidherbia albida*	Gawo	Fabaceae	6	12	2.05
17	*Ficus polita*	Durumi	Moraceae	1	2	2.56
18	*Ficus thoningii*	Chediya	Moraceae	1	2	0.51
19	*Gardenia erubescens*	Gaude	Rubiaceae	3	6	0.51
20	*Guera senegalensis*	Sabara	Combretaceae	14	28	1.54
21	*Khaya senegalensis*	Madacci	Meliaceae	1	2	7.18
22	*Mimosa pigra*	Gumbi	Fabaceae	4	8	3.1
23	*Parkia biglobosa*	Dorawa	Fabaceae	11	22	0.51
24	*Prosopis africana*	Kirya	Fabaceae	9	18	5.64
25	*Sclerocarya birrea*	Loda	Anacardiaceae	10	20	4.62
26	*Vitellaria paradoxa*	Kade	Sapotaceae	4	8	5.13
27	*Vitex doniana*	Dinya	Lamiaceae	4	8	2.05
28	*Ziziphus mauritaniana*	Magarya	Rhamnaceae	6	12	3.08
			Total	195	390	100

D/Ha^{-1}= Density per Hectare: RD= Relative Density

CONCLUSION

This study assessed the composition and structure of woody species in Lema reserve using a field survey approach. The composition was dominated by few species while the density was generally low. The mean species diameter was rather high, signifying the presence of many large stems in the reserve. However, there was vivid evidence of human pressure on the species in the form of farmland expansion, exploitation of fuelwood and overgrazing by animals. Measures need to be taken to preserve the few available species in the reserve for its overall ecological health. Provision of cheap and readily available alternative sources of energy is also recommended to replace fuelwood as the main source of domestic energy in the area.

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