

Floristic Composition and Characterization of Legume flora in Parklands of Aguié Department, Niger, West Africa.

ABSTRACT

Due to the absence of a botanical assessment on legume flora in Aguié, so the study was conducted on parklands of Aguié Department to determine the floristic composition and characterize the flora. The characterization consists of determining the legume woody flora density, vertical structure, number of sapling, herbaceous legume biomass and importance socio-economic. Firstly, we used systematic sampling approach to collect legume flora. A total 51 plots each with a size of 50mx50m for all parklands species and within each major quadrat, five sub plots of 5mx5m and 1mx 1m were established for the woody regeneration and for herbaceous biomass. All plant species in each plot were recorded. The legume flora was extracted. Some dendrometric parameters such as height, diameter at breast height(1.30m) and the crown cover were measured. Secondly, we used ethnobotanical questionnaire to collect the socio-economic data about the importance of legume flora to the rural communities. On the other hand, a total of 61 legume species representing 30 genera and the three botanical families namely Fabaceae, Mimosaceae and Caesalpiniaceae. Fabaceae is the floristically the highest family with 30 species representing 13 genera. Mimosaceae constitutes the second family with 16 species representing 7 genera. Caesalpiniaceae was presented with 15 species and 8 genera. The average density of legume woody species is 80 feet per hectare in the parklands. The structural analysis of the parklands revealed that there were two vertical structures namely tree and shrub strata. Ethnobotanical surveys within the parkland communities with 52 people show that legumes play a crucial role in meeting diverse domestic and environmental needs. Among the legumes recorded are cultivated, medicinal, pastoral, ornamental, gommiferous, honeydew and spontaneous food species. Consequently, based on the results, a further study that will examine the threat to the legume flora is recommended.

Keywords: Floristic composition, Legume Flora, Characterization, Parklands, Aguié

1. Introduction

Niger (longitude 0°16' and 16° East and the latitude 11°1' and 23°17' North) is one of the vast sahelian countries in West Africa covering an area of 1,267,000km². The population of Niger is 17.7million of people and its population growth rate is 3.9%(INS). Nearly 80% of its population live in rural areas where Nigeriens derive various ecosystem services. Parklands provide enormous services to the rural dwellers in Niger. For instance, parklands constitute the source of firewood, traditional medicine for human and animal, timber, animal fodder and human food such as edible fruits and leaves in Niger (Mahamane,1997, Dan guibe 2011,

39 Hamidou et al.,2015 & Soulé et al.,2016). More specifically, fuelwood such as firewood and
40 charcoal remains the widely source of energy in rural areas of Niger. Further, in Aguié
41 department parklands are the major source of fuelwood. Parklands are also a great source of
42 income in the rural areas.

43 Botanical assessment of the flora of a region is of overwhelming importance especially to the
44 management of the phytodiversity. Legume flora is of high importance to a given ecosystem.
45 Legume species have played a very important role in ecosystem and human life (Fadl et
46 al.,2015). In addition, a lot of legume species have the ability to fix atmospheric nitrogen
47 with the support of the bacteria such ability is of great importance in ecosystem
48 functions(Sprent,2009). Added to that some legume species are used or saved as green
49 fertilizers in the parklands in Niger. Furthermore, legume plants are of great importance due
50 to their role in nitrogen fixation. For instance, (Serraj et al., 2004) concluded that legume
51 plants sustain crop productivity and augment land fertility of the semi-arid environment.

52 In Aguié department the parklands consist of agricultural landscape, pastoral lands, forest
53 reserve under contract of cultivation or taungya farming activities with scattered woody
54 species. The parklands refer to the agroforestry systems or agroecosystems. Characterization
55 of legume flora consists of determining the dendrometric characteristics, regeneration rate
56 and legume herbaceous biomass in the parklands of Aguié department. Legume refers to the
57 order of legumisosa that has three botanical families namely Caesalpiniaceae, Fabaceae or
58 Papilionaceae and Mimosaceae.

59 **2. Materials and Methods**

60 **2.1 Study area**

61 Aguié is one among the departments of Maradi region in Niger. Aguié department lies
62 between 13°51'21''N and 08°18'12''E (Fig. 1). The people of Aguié was estimated at
63 386.197 (INS,2011). Agriculture is the main activity of the population of Aguié. The
64 agricultural production consists of food and cash crops. Apart from that, the people of Aguié
65 department are engaged in animal husbandry. Residential animal husbandry in Aguié consist
66 of keeping animals in the houses during dry and rainy spell. But during dry season the
67 parklands constitute the free range of the animals. In the rainy season, the forage is collected
68 from the parklands to the houses. The climate of Aguié is south sahelian type with following

characteristics(Saadou,1990): Rainfall index = $400\text{mm} < \text{RI} < 600\text{ mm}$; relative humidity = $18\% \text{ (March)} < \text{RH} < 70.5\% \text{ (August)}$; Temperature = $19^{\circ}\text{C} \text{ (January)} < T^{\circ} < 32^{\circ}\text{C} \text{ (May)}$. The relevés sites were at the following villages Dodo, Bamo, Dan kéri, Gamji Saboua, Guidan Tanko, Guidan Nahantchi, Saja Manja, Bakabé, Mai Sanho, Dan Saga, Aguié commune, and Dan Kada, which were randomly selected.

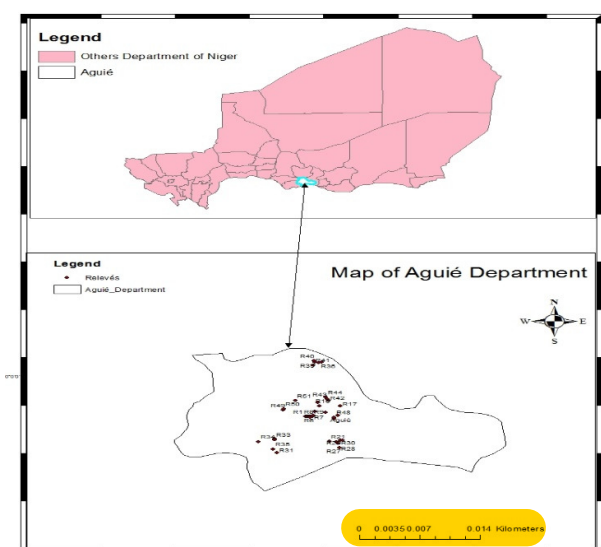


Figure 1. Map of Aguié department

2.2 Data collection

The inventory was carried out during August and September, period corresponding of optimum vegetation development in sahelian milieu(Saadou,1990). During such period the herbaceous vegetation is developed and easy to identify. Plot method or quadrat method was used to inventory the vegetation data in the parklands of Aguié by using systematic sampling approach. The size of the quadrat was $50\text{m} \times 50\text{m}$ which is the recommended for the agroforestry systems inventory (Thiombiano et al.,2008). We used tape meter and ringing pole for the construction of the plot. Within each plot, five sub plots of $5\text{m} \times 5\text{m}$ and $1\text{m} \times 1\text{m}$ were established for the woody regeneration and for herbaceous biomass. A total 51 plots were used and within each major quadrat, all plant species in each plot were recorded. The majority of species was identified by us during the terrain. Some specimens were collected by

the unknown species which were identified by Doctor karim Saley at the department of Biology, faculty of Science University Dan Dicko Dankoulodo of Maradi. For the herbaceous biomass, we cut only the herbaceous legume within the five sub plots in every plot. We weighted the herbaceous legume using the small spring balance in field for the fresh weight. Secondly we dried at home and measured for the dry weight. Some dendrometric parameters such as height, circumference at(1.30m) and the-crown cover were measured. We used ringing pole for the total woody legume species-and tape meter for crown cover measurement and diameter tape for legume woody species diameter at 1.-30m. We also measured the diameter South-North and West-East of the woody crown. Secondly, we used ethnobotanical questionnaire to collect the socio-economic data about the importance of legume flora to the rural communities. We took some pictures that explain the use of legume flora in Aguié.



Picture 1. Showing Soulé administrating the questionnaires.

3. Data analysis

All the vegetation data of the inventory were taped and-analysed in Excel. After, the legume flora was extracted from the whole data. We analysed the data with Excel for following information about the legume flora of the parklands:

We used the formula circumference (C)= diameter x Pi (3.14) = d.π, so you get a diameter= Circumference(C) divide by Pi.

Density (N) of a specie or group of species is the number of ~~feet~~ per unit of area ~~per hectare~~.

$N = \frac{N}{A}$; Where n is the number of individuals and A is the area in hectares.

Basal area (G) is the area of a given section of land that is occupied by the cross-section of woody specie trunks and stems at the base. The basal area is calculated on the basis of trunk diameter and expressed in m² per hectare. It is obtained by the following formula: $G = \pi D^2 / 4$, where D is diameter at breast height(1.3m).

Crown Cover (R) is the area of vertical projection of the woody crown on soil. It is calculated by the following formula: Crown cover = (Average crown diameter)² x (π)/4, where Average crown diameter is equal to the sum of the diameter South-North and West-East of the woody crown divide by two. The crown cover is expressed in percentage (%).

Rate of regeneration(Rr) is defined as the ~~rapport~~ of the total number of sapling/seedlings counted on the total plot area per hectare. $R_r = \text{Total number of seedlings} / \text{Area(ha)}$. Here we consider seedling or sapling any woody plant which is diameter is less than 2.5 cm (which the minimum diameter in semi area zone and the height less than 1.3m).

4. Results and Discussion

4.1 Legume Floristic Composition

The floristic analysis of the legume flora of Aguié parklands shows a total of 61 (~~Table 1~~) legume species were recoded representing 30 genera and the three botanical families namely Fabaceae, Mimosaceae and Caesalpiniaceae. Fabaceae is ~~the~~ floristically the ~~highest~~ family with 30 species representing 13 genera. The best represented genera in the Fabaceae are *Indigofera* with 10 species, *Crotalaria* with 4 species, *Tephrosia* with 3 species. This result is significantly lower than the number of species of this Family found by (~~Saadou et al., 2012~~) in the same ~~Compartment~~. The woody flora of Fabaceae in parklands of Aguié has two species which are: *Pterocarpus erinaceus* and *Dalbergia sissoo*, ~~which is~~ an introduced legume. ~~But~~ one *Pterocarpus erinaceus* was recorded during our survey. Mimosaceae constitutes the second family with 16 species representing 7 genera. But *Acacia* genus has 7 species, *Albizia* 2 species, and *Prosopis* ~~with~~ 2 species. ~~But~~ *Prosopis juliflora* was ~~exotic plants~~. The number of *Acacia* species (7) we obtained is less than the ~~Acacia number~~ (14) found by (~~Saadou et al., 2012~~) in the same ~~compartment (B)~~. This result ~~could always~~ be explained by the fact that the study is carried out only in the Aguié department and only the few villages were randomly prospected for the study. We collected also an exotic species *Acacia holosericea*, which was not found in compartment B by (~~Saadou et al., 2012~~). Caesalpiniaceae was ~~presented~~ with 15 species and 8 genera. The best represented genus is

the Cassia genus with 9 species; This is consistent with the result found in compartment B by (Saadou et al., 2012) by contrast a single species that was not harvested, *Cassia senna* but found by (Saadou et al. 2012) in the compartments D and E. Caesalpiniaceae of the parklands of Aguié has 9 woody species. *Parkinsonia aculeata* is the also exotic plant. Our result classifies the Fabaceae as first family, second Mimosaceae and third was Caesalpiniaceae. This confirms the result found by Fadl et al., 2015 in Taif district, Saudi Arabia in terms of order of numerical importance. But in this study we find 61 species while Fadl et al. 2015 found 26 species. The presence of introduced woody legume species indicates the afforestation activity within the parklands.

Table 1. Legume Floristic composition

Botanical families	Number of Species	Number of Genera
Fabaceae	30	13
Mimosaceae	16	7
Caesalpiniaceae	15	8
Total	61	28

4.2 Characterization of Legume Flora

4.2.1.1 Legume woody species density

The average density of woody legume species is 80 feet per hectare in the parklands of Aguié department. It varies from 36 feet per hectare for *Piliostigma reticulatum*, 7 for *Faidherbia albida* feet per hectare, 4 for *Acacia nilotica* individuals per hectare and 3 for *Prosopis africana* (table 2). For these four species the department of Aguié has a spatial distribution which is somewhat continuous. The most numerically dominant species in the parklands of Aguié department is *Piliostigma reticulatum*. The average density of legume woody flora and for the three woody species were greater than the result (1.17 *Pterocarpus erinaceus* per hectare in sahel) found by Segla et al. 2016 found for *Pterocarpus erinaceus*. Further in this study we found only one *Pterocarpus erinaceus*. This confirms the weak density of *Pterocarpus erinaceus* found by Segla et al. 2016 in sahel environment.

Table 2. Relative density of woody legume plants

Legume woody species	Relative density(ha)
<i>Piliostigma reticulatum</i>	36
<i>Faidherbia albida</i>	7
<i>Acacia nilotica</i>	4
<i>Prosopis africana</i>	3

4.2.1.2 Basal Area and Crown Cover

The total basal area of legumes in the parklands of Aguié is the sum of all the land areas of legume species on the inventoried area. It is 14.34m² / ha in the parklands of Aguié. The basal area for the woody flora is greater than (0.30 m²/ha) what Segla et al.,2016 found for only for *Pterocarpus erinaceus* in sahel area. The basal area plays a great role in parklands management and parklands ecology. The crown cover of woody legume plant is 4.71% for the department of Aguié. Our finding is lesser than the findings of Larwanou et al.,2012 in parklands of Maradi region. Crown cover in the parklands of Aguié varies according to the land use land cover types. It is higher in the forest reserves(Table3). This could be due to the artificial plantations of legumes and to the protection of the forest reserve. While it is lower in the croplands. This is justified by the fact that the trees in the croplands are very poorly pruned for aerial grazing and cut during the cropping period in order to reduce the shading effect on the crops. In the fallows, this could be explained by the aerial cuts by the breeders and wood by the woodcutters.

Table 3. Crown Cover in the different land use land cover types

Crown Cover	Croplands	Fallow lands	Forest reserves
%	4.70	4 .90	14

4.2.1.3 Vertical Structure of Legume Woody Flora

Based on the legume vertical distribution diagram by height class(Figure2), the parklands of Aguié has two structures, the shrub stratum whose representatives are in the majority, and the tree stratum whose individuals of this stratum are poorly represented. Shrub stratum constitutes the major vertical structure of legume flora in the parklands of Aguié. The dominance of such a structure could explain the impact of human activities on woody plant in the parklands. But our findings, the two vertical structures and even the dominance of shrub stratum confirm the result of Larwanou et al.,2012 in the parklands of Maradi region.

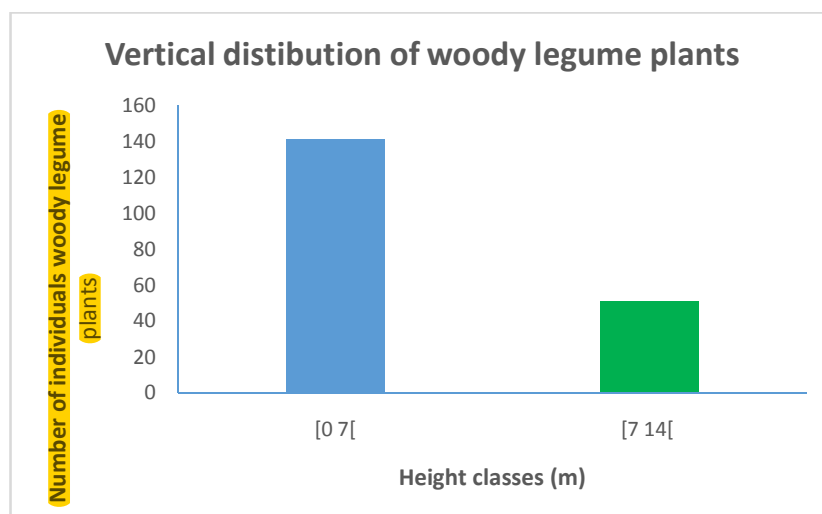


Figure 2: Distribution of woody legumes by height class

4.2.1.4 Natural regeneration and Herbaceous legume biomass

In the parklands of Aguié department, there are 28 legume seedlings per hectare which is smaller than the regeneration rate of the mixed woody flora found by Larwanou et al., 2012 in their study sites. Number of seedling per hectare represents a rate of regeneration which is a good indicator of appreciating the regeneration capacity. Herbaceous legume biomass is 0.40 tons of dry matter per hectare in the parklands of Aguié department.

4.2.2 Importance socio-economic

The ethno-botanical survey in the parklands communities in Aguié department shows that the legume flora plays a major role in satisfying the socio-economic needs of people. The inventoried legumes include cultivated plants; medicinal plants; pastoral plants; glue- plants; ornamental plants; honey plants; and other wild spontaneous food plants and crops. Some legume species are economic such as *Parkia biglobosa*. For instance, the wild legume *Cassia obtusifolia* or *tora* has been domesticated. From the interviewers, the seeds are sold in the markets.



Picture 2. Showing the cropland of *Cassia obtusifolia* and the farmer using it for food

5. Conclusion

The parklands of Aguié department are rich in legume biodiversity. The floristic composition is diverse in terms of species, genera and families. The legume flora of the Aguié department is characterized by dominance of legume woody species namely *Piliostigma reticulatum* and *Faidherbia albida*. The structural analysis of the parklands revealed that there were two vertical structures namely tree and shrub strata. The current study augments our knowledge of wild legume vegetation in parklands of Aguié department. Based on the results, a further study that will examine the threat to the legume flora is recommended.

Table.4 Legume floristic list

Species	Families
<i>Bauhinia rufescens</i> Lam.	Caesalpiniaceae
<i>Cassia absus</i> L.	Caesalpiniaceae
<i>Cassia italica</i> (Mill.) Lam. Ex Fw.Andr	Caesalpiniaceae
<i>Cassia mimosoides</i> L.	Caesalpiniaceae
<i>Cassia nigricans</i> Vahl.	Caesalpiniaceae
<i>Cassia obtusifolia</i> L.	Caesalpiniaceae
<i>Cassia occidentalis</i> L.	Caesalpiniaceae
<i>Senna siamea</i> L.	Caesalpiniaceae
<i>Cassia sieberiana</i> DC.	Caesalpiniaceae
<i>Cassia singueana</i> Del.	Caesalpiniaceae
<i>Delonix regia</i> (Hook.) Raf.	Caesalpiniaceae
<i>Detarium microcarpum</i> Guill. Et Perr.	Caesalpiniaceae
<i>Parkinsonia aculeata</i> L.	Caesalpiniaceae
<i>Piliostigma reticulatum</i> (Dc.) Hochst	Caesalpiniaceae
<i>Tamarindus indica</i> L.	Caesalpiniaceae
<i>Aeschynomene indica</i> L.	Fabaceae
<i>Alysicarpus ovalifolius</i> (Schum. Et Thonn.)	Fabaceae
<i>Arachis hypogaea</i> L.	Fabaceae
<i>Canavalia rosea</i> (L.) DC.	Fabaceae
<i>Crotalaria goreensis</i> Guill. Et Perr.	Fabaceae
<i>Crotalaria podocarpa</i> DC.	Fabaceae

<i>Crotalaria retusa</i> L.	Fabaceae
<i>Crotalaria senegalensis</i> (Pers.) Bak. Ex.DC.	Fabaceae
<i>Dalbergia sissoo</i> DC.	Fabaceae
<i>Indigofera astragalina</i> Dc.	Fabaceae
<i>Indigofera berhautiana</i> Gillet	Fabaceae
<i>Indigofera bracteolata</i> DC.	Fabaceae
<i>Indigofera dendroides</i> Jacq.	Fabaceae
<i>Indigofera diphylla</i> Vent.	Fabaceae
<i>Indigofera hirsuta</i> Var.hirsuta	Fabaceae
<i>Indigofera nummulariifolia</i> (L.) Liv. Ex Alston	Fabaceae
<i>Indigofera pilosa</i> Poir.	Fabaceae
<i>Indigofera stenophylla</i> Guill. Et Perr.	Fabaceae
<i>Indigofera tinctoria</i> L.	Fabaceae
<i>Pterocarpus erinaceus</i> Poir.	Fabaceae
<i>Sesbania pachycarpa</i> Dc.	Fabaceae
<i>Stylosanthes erecta</i> P.Beauv.	Fabaceae
<i>Tephrosia bracteolata</i> Guill. Et Perr.	Fabaceae
<i>Tephrosia linearis</i> (Willd.) Pers.	Fabaceae
<i>Tephrosia lupunifolia</i> DC.	Fabaceae
<i>Tephrosia obcordata</i> (Lam.ex Poir.)	Fabaceae
<i>Tephrosia purpurea</i> (L.) Pers.ssp.	Fabaceae
<i>Vigna subtereranea</i> (Thouars (L.)) Verdec.	Fabaceae
<i>Vigna unguiculata</i> (L.) Walp.	Fabaceae
<i>Zornia glochidiata</i> Reichb.ex Dc.	Fabaceae
<i>Acacia ataxacantha</i> Dc.	Mimosaceae
<i>Acacia holosericea</i> A.Cunn.ex G.Don	Mimosaceae
<i>Acacia nilotica</i> (L.) Willd. Ex Del.subsp.nilotica	Mimosaceae
<i>Acacia polyacantha</i> Subsp.Campylacantha	Mimosaceae

<i>Acacia senegal</i> (L.) Willd.	Mimosaceae
<i>Acacia seyal</i> Del.	Mimosaceae
<i>Acacia sieberiana</i> DC.	Mimosaceae
<i>Acacia tortilis</i> Subsp. <i>raddiana</i>	Mimosaceae
<i>Albizia chevalieri</i> Harms.	Mimosaceae
<i>Albizia lebbeck</i> (L.) Benth.	Mimosaceae
<i>Dichrostachys cinerea</i> (L.) Wight et Arn.	Mimosaceae
<i>Entada africana</i>	Mimosaceae
<i>Faidherbia albida</i> Del.	Mimosaceae
<i>Parkia biglobosa</i> (Jacq.) Benth	Mimosaceae
<i>Prosopis africana</i> (Guill. Et Perr.) Taub.	Mimosaceae
<i>Prosopis juliflora</i> (SW) DC.	Mimosaceae

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