http://dx.doi.org/10.22161/ijeab/2.3.38 *ISSN: 2456-1878*

Floristic Composition, Structural Analysis and Socio-economic Importance of Legume Flora of the Commune of Mayahi, Niger, West Africa

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Abstract— *Floristic assessment plays a crucial role in managing and conserving phytodiversity. Thisstudy tried to determine the floristic composition, woody structure and socio-economic importance of the legume flora in the commune of Mayahi. We used plot method based on systematic sampling approach to inventory legume species within the parklands in September 2012. We recorded 55 legume species belonging to 24 genera in 56 relevés. Fabaceae is the dominant family among the legume botanical families in the parklands of the commune of Mayahi. The average woody legume density is 62 individuals per hectare in the commune of Mayahi. The woody legume species of highest average density are Faidherbia albida and Piliostigma reticulatum. While the total basal area of legumes of the commune is 1.12m^2 / ha in the Mayahi commune. The crown cover varies according to the vegetation types but it is higher in the Goulbi N'kaba forest reserve. Legume flora provides a myriad of benefits to the people of Mayahi. The present study recommends furtherresearch that examines the impact of human activities on the legume flora of the parklands in the commune of Mayahi.*

Keywords— Legume flora, Dendrometry, Socio-economic importance, Commune of Mayahi, Niger.

I. INTRODUCTION

Niger has four climatic zones climatic zones that have contributed to the formation of The Sudanian and Sahelo-Saharan environments characterized by a great biodiversity of both animals and plants. Niger covers a surface area of 1,267,000 sq km. It is located between the longitude 0°16' and 16° East and the latitude 11°1' and 23°17' North. Niger human population was estimated at 19.8 million people and a population growth rate at 3.9 % (World Bank, 2016). About 80% of its human population lives in rural areas where it derives various ecosystem services (INS, 2011).Indeed, vegetation changes is one of the greatest ecological problems in Niger. Niger' ecosystems are prone to the high pressure due to the high population expansion that exercises great demand such us the firewood, absence of fallow and expansion of agricultural lands to forest areas. In addition, the climate vagaries has also huge impact of vegetation in Niger. Added to that, ecosystems of Niger are prone to unsustainable management due to such as inappropriate agricultural practices, illegal and unsustainable logging activities and unsustainable pastoral activities (CNEDD, 2006). Such practices lead to compositional and structural changes of vegetation and biodiversity loss, which would have huge impacts on the environment and socio-economic setup of the Niger communities.

Legume species are known to be critically important in an ecosystem in terms of building and conserving soil fertility. Most legume species have nodules on the root systems, which enable them to absorb the atmospheric nitrogen and convert it into the nitrogen the plant needs for its development. Therefore, legume flora plays a crucial role in the ecological systems. For instance, in Niger, legume flora provides a myriad of benefits such as firewood, timber, fodder, melliferous, gun and food species, traditional medicine for human and animal (Hamidou et al., 2015 and Soulé et al., 2017).Legume species belong to the order of leguminosae that comprises three main botanical families such asCaesalpiniaceae, Fabaceae or Papilionaceae and Mimosaceae. Leguminosae is oneof the largest and most useful orders in the world. For instance, Bellefontaine(2005) stated that *Faidherbia albida* is very important pastoral woody species in the Sudano-Sahelian areas. Further, Ouedraogo-Kone et al., 2008 found out that *Faidherbia albida* has the strongest use indices and it is very good nutritious pastoral woody plant. Furthermore, *Cassia*

http://dx.doi.org/10.22161/ijeab/2.3.38 *ISSN: 2456-1878*

obtusifolia (*Cassia tora*) is a wild legume specie cultivated in Niger for its leaves as food in dry and rainy season in Aguié, Maradi region (Soulé et al, 2017)

Botanical evaluation such as floristic composition, dendrometric analysis studies are important for providing information on species richness of the ecosystems, useful for the ecosystem management goal and help in apprehending ecology and functions of ecosystem (Pappoe et al., 2010). Data on the floristic composition and structure of ecosystem is also useful in managing sustainably the ecosystem (Addo-Fordjour et al., 2009).The aim of this study was therefore, to list the floristic composition and make structural analysis of the legume flora of the commune of Mayahi in Niger.

II. MATERIALS AND METHODS

1.1 Study area

The commune of Mayahi is located in Maradi region of Niger republic. The commune of Mayahi has an estimated population of 94,160 inhabitants in 2011 (PDC, 2011).The commune of Mayahi has fifty nine (59) administrative villages and tribes. The capital of the commune is Mayahi. Agriculture is the principal economic activity of the people of the commune of Mayahi. *Vigna unguiculata* (cowpea) and*Arachis hypogaea* (peanut) constitute the cash legume crops. Animal husbandry is the second economic activity of the people of the commune of Mayahi. One of the major vegetation types of the commune of Mayahi is parklands that consists of croplands and pasturelands with the scattered woody species. The people of the commune of Mayahi exploit many parklands services such as firewood, forage for livestock, food (fruits, leaves). They exploit the parklands for medicinal purposes. The climate of the commune of Mayahi is the Sahelian type, characterized by a short rainy season usually three to four months from June to September. The total amount of rainfall estimated in 2015 was 380.9 mm (DDA, 2015).The study sites were Mayahi urban commune, Digaba, Guidan Sani, Guidan Alou, Koren Habjia, Loda, Dan Amaria, Achalou, Kotaré, they were randomly selected.

1.2 Inventory Sampling design

The survey took place in September 2012, whichis the period of the maturity of herbaceous species in Sahel (Saadou, 1990). A systematic sampling technique was used due to the homogeneity of the landscape to collect vegetation data. Plots of size 50m x 50m (2500m^2) were used for woody species, one subplots of 100 m^2 (10 mx 10 m) at one corner of the main plot and subplots of 1m x1 m for herbaceous density at the four corners and one at the centre of the large plot. We constructed also five subplots at the angle and one at the centre of the large 5 m x 5 m for recording the seedlings.Plots were laid systematically at every 500m along transect lines, which were 500m apart from each other. Ringing pole, tape meter and GPS were used the fieldwork. All the plot sizes used correspond to the minimum areas for agroforestry systems and steppe (Mahamane & Saadou, 2008). The plots were shown in Figure 1.

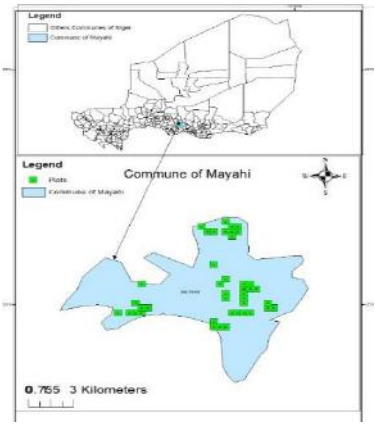

Fig.1: Location of the study area

1.3 Data collection

We did firstlySystematic counting of all the plant species in the subplot of 100m^2 and secondly in the large plot. Thirdly,we used destructive method for the herbaceous biomass; we removed all the herbaceous species within the five subplots in each large plot. Nevertheless, we separated only the herbaceous legume within the five sub plots in each large plot. We counted the fresh herbaceous legume manually.If there were some woody species within the large plot, we took some dendrometric variables such as height; circumference at 1.30 m for the tree and 20 cm for the shrubs and crown cover were measured. We considered tree as any woody plant superior to 7 m of height and less than 7 m was considered as shrub.

We used ringing pole and tape meter for the dendrometric variables measurement. We also measured the widest diameter and perpendicular diameter of the woody crown by using tape meter. Furthermore, the seedling were recorded. Theseedling refers to any woody plant, which is diameter is less than 2 cm and the height less than 1.3 m. Additional plant species occurring outside plots but were also recorded only as present and were added to the final legume floristic list. Finally, we used ethnobotanical questionnaire to collect the socio-economic data about the importance of legume flora to the people of the commune of Mayahi. We took some pictures that explain the use of legume flora in the commune of Mayahi. We used two approaches for specie identification. Firstly, we have identified the majority of the species in the field. Further,

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we used also some books for the identification in field such as the flora of Hutchinson (1972), Adventrop (1995) and Michel Arbonnier (2002). For theunknown species, we produced the herbarium and submit to the Department of biology University Dan Dicko Dan Koulodo of Maradi for the specie identification.

1.4 Data analysis

All the collected vegetation data were taped in Excel. After, the legume vegetation data were extracted from the entire data. For the description of legume structure, woody species density, height, diameter at breast height (DBH), basal area, crown cover and regeneration rate were used. We analysed the data with Excel for following information about the legume flora of the vegetation of the Mayahi commune. We calculated:

- **Density (N)** of a specie or group of species is the number of individuals per unit of (nb/ha). Further, the average woody species density was the ratio of the total number of individuals to the total survey area, and then reported to the hectare.

$$D = \frac{10000\ x\ N}{S}$$

- **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. Further the total woody species crown cover was expressed using $R = \frac{100\pi}{4S}\sum_{i=1}^{N} Di^2$; where R (%) = total crown cover, S = total survey area, Di is the average diameter of the individual crowns, and N is the total number of individuals.The crown cover is expressed in percentage of plot area. However, as we measured the circumference, we used the formula circumference (C) = diameter x Pi = d.π, so you get a diameter = Circumference(C) divide by π. Where the value of π = 3.14.
- **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 based on trunk diameter and expressed in m^2 per hectare. It is obtained by the following formula: $G = \pi D^2/4$, where D is diameter at breast height for the trees (1.3 m) and 2 cm for the shrubs. $G = \frac{10000\pi}{4S}\sum_{i=1}^{N} di^2$; whereG (m^2 / ha) = Total basal area, S = total survey area, di diameter of individuals and N total number of individuals.
- **Rate of regeneration (Rr)**is defined as the ration of the total number of sapling/seedlings counted over the total plot area per hectare. Rr =Total number of seedlings/ Area (ha).Descriptive statistic was used for analysing the questionnaire data.

III. RESULTS AND DISCUSSION

3.1 Floristic Composition

A total of 55 legume species belonging to 24 genera and 3 families were identified from the agroforestry systems of the commune of Mayahi. Fabaceae and Caesalpiniaceae were found to be the dominant families in the inventoried legume flora of the commune of Mayahi represented by 12 (50 %) genera and 28 species (51%) and 14 species (25%) respectively in table 1. The Caesalpiniaceae and Mimosaceae have equal number of the genera. Our findings confirm that Fabaceae is the first botanical families of leguminosae order (Burju et al., 2013 &Soulé et al.,2016) who found respectively that the Fabaceae was the first families among the leguminosae in Jibat Humid Afromontane Forest of Ethiopia and the of parklands of commune of Mayahi. *Pterocarpuserinaceus* was not recorded at all during the inventory. This confirms also the result of Boubacar (2010) who found out that *Pterocarpuserinaceus* has disappeared from the department of Mayahi. This was also supported during our interview with the villagers of the commune of Mayahi that *Pterocarpuserinaceus* from their commune.The absenceof *Pterocarpuserinaceus* in the inventoried flora of the commune of Mayahi confirms the findings of Arbonnier (2004) who reported that the specimen of the *Pterocarpuserinaceus* decrease and tend towards extinction in Niger. Furthermore, Sokpon et al. (2006) stated that *Pterocarpuserinaceus* has disappeared from many sites in Niger. Moreover, Rabiou et al. (2015) found out that in the Sahelian zone and even Niger W Park there were lack of seedling of *Pterocarpuserinaceus* indicating that the specie faces a problem of regeneration. Added to that *Parkiabiglobosa*was not also inventoried during our fieldwork in the commune of Mayahi. From the interview with the people of the commune of Mayahi, *Parkiabiglobosa* has also disappeared from their commune. In addition, the specie *Prosopis africana* is also rare in the commune of Mayahi because during all our prospection, only three individuals have been obtained and the population of the commune among the threatened species classifies this specie.

Table.1: Legume floristic composition

Families	No. of Genera	%	No. of Species	%

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Fabaceae	12	50	28	51
Caesalpiniaceae	6	25	14	25
Mimosaceae	6	25	13	24
Total	24	1	55	1

3.2 Structural Analysis

- **Legume woody species density**

The average woody legume density is 62 individuals per hectare in the commune of Mayahi. The woody legume species of highest average density are *Faidherbia albida* and *Piliostigma reticulatum* (Table 2). The dominance of the two woody legume species in the agroforestry systems of the commune of Mayahi is an indicator of selective farmers Managed Natural Regeneration (FMNR). This means the farmers select the two species because of their importance in their farmlands. Our results corroborate the findings of Savadogo et al. (2015) who stated that *Piliostigma reticulatum* and *Faidherbia albida* are predominant in the degradation zone of their study area in Mayahi department. The three dominant legume species are *Faidherbia albida* (122 individuals), *Piliostigma reticulatum* (64), and *Acacia tortilis* (49).

Table.2: Relative density of woody legume plants

Woody Legume Species	Relative Density (hectare)
Acacia nilotica	2
Faidherbia albida	22
Piliostigma reticulatum	15

- **Crown Cover**

The woody crown cover of the commune of Mayahi varies according to the land use and land cover types. It is higher in the Goulbi N'kaba valley (table 3), because Goulbi N'kaba forest is an environment highly protected by the foresters of the commune of Mayahi. Added to that Goulbi N'kaba vegetation belongs wetlands vegetation. The high crown cover observed in the forest of Goulbi N'kaba valley may be due the level of environmental perception of the surrounding population of forest degradation consequences. On the other hand, it is less elevated in farmlands, which explains the protection of woody plant by the principle of tree tenure and ownership. In addition, this may be due to the practice of natural assisted regeneration. The crown cover is lower in the fallow lands, which may be due the pastoral pressure as there is scarcity of pastoral land in the commune and illegal logging.

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Table.3: Crown Cover in Land Use Land Cover types

Crown Cover	Farmlands	Fallow land	Goulbi Kaba forest
%	4.40	3.45	9.90

- **Basal area**

The total basal area of legumes of the commune is the sum of all the basal areas of legume species on the inventoried area. It is 1.12m^2 / ha in the Mayahi commune. The analysis of these two table shows that the basal area is large for *Faidherbia albida*and *Acacia tortilis*.

Table.3: Basal area of some woody legume plants

Woody Legume Species	Basal area(m^2 / ha)
Acaciatortilis	0.034
Faidherbia albida	0 .065
Piliostigma reticulatum	0.028

- **Regeneration rate and Legume herbaceous density**

There are 25 seedlings of legume per hectare in the commune of Mayahi. The herbaceous legume of high average density were *Zornia glochidiata* (89.02 individuals / m^2) and Alysicarpus ovalifolius (40.34 individuals / m^2). The two herbaceous legume species are the pastoral species.The average density of each species

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was determined in order to assess their contribution to biomass

- **Diameter and Height of Some woody legume species distribution in three geomorphological units : Plain, Valley and Plateau**

Analysis of the figure 2 shows that *Faidherbia albida*is distributed in all geomorphological units, with greater density at the plain. The diameter and height all have a symmetrical structure at plateau and plain. The high density in these units is due to large *Faidherbia albida*parklands we meet at some locations such as Guidan Alou Guidan Sani, etc.

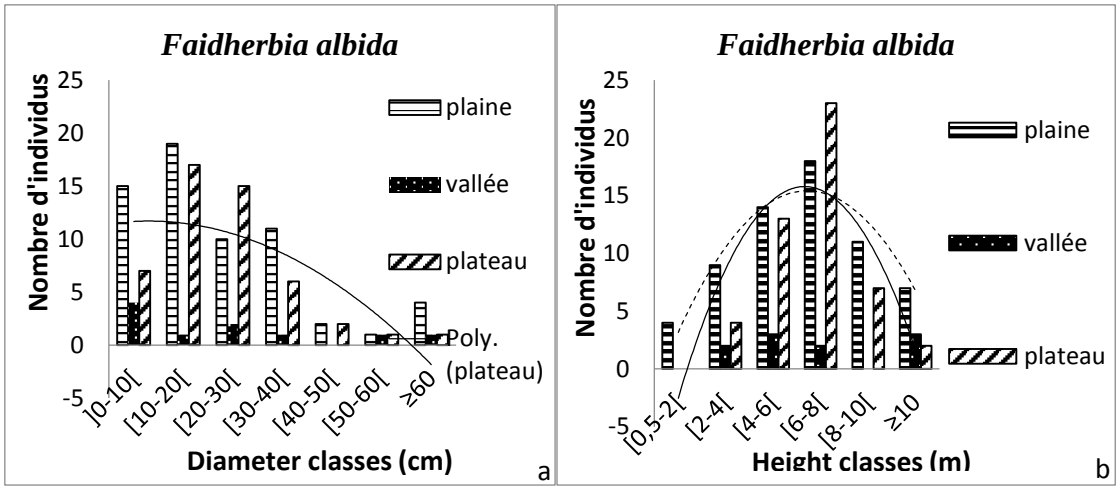

Fig.2: diameter distribution (a) and height distribution (b) of Faidherbia albida

The structure of diameter and height of *Piliostigma reticulatum* shows a predominance of young individuals at the level of the plain whereas the aged individuals are totally absent (Fig3). This can be explained by the exploitation of individuals with large diameter in agroforestry systems. Moreover, the species is represented on the plateau only by individuals with an average diameter and at the level of the valley, this class is absent.

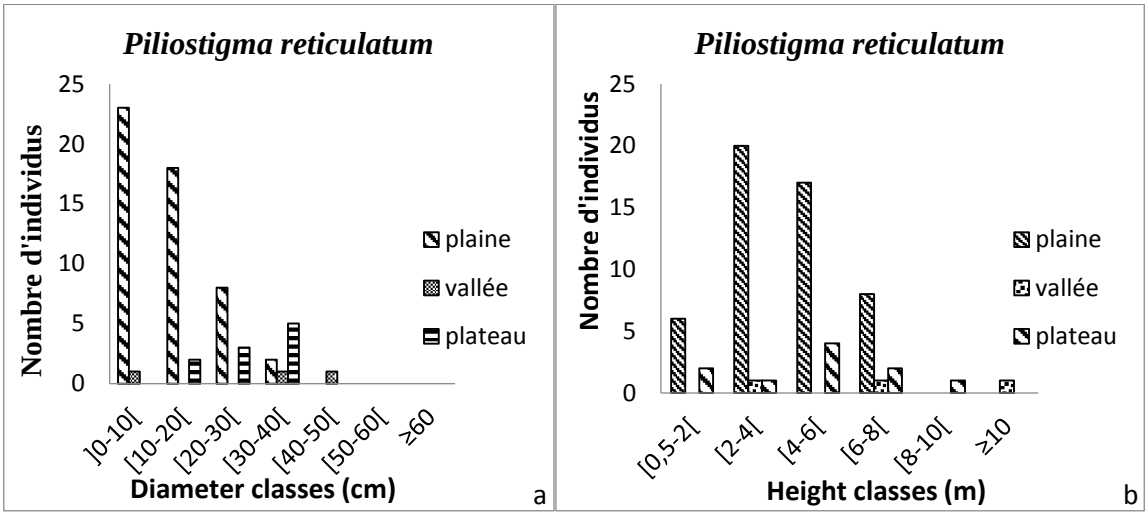

Fig.3: diameter distribution (a) and height distribution (b) of Piliostigma reticulatum

The analysis of the graph 4 shows that *Acacia tortilis*is well distributed in the plain and in the valley than in the plateau. Both parameters have a bell structure, which means that the specie recovers well in these units. Indeed, this specie dominates the physiognomy of the vegetation of Goulbi N'kaba, which is a protected area. This also supports the high crown cover we observed in the Goulbi N'kaba forest. In short based on the height distribution of the three legume woody plants, the woody legume flora of the commune of Mayahi has two strata such as tree stratum and shrub stratum.

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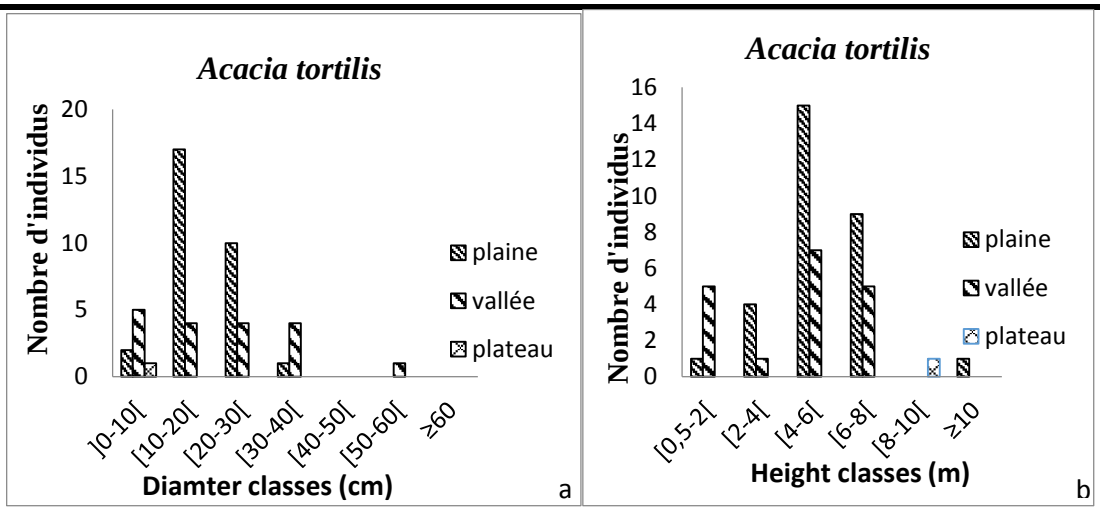

Fig.4: diameter distribution (a) and height distribution (b) of Acacia tortilis

3.3 Socio-economic Importance

The questionnaire data analysis from 52 people reveal that the legume species provides a diversity of services to the population of Mayahi commune. They are source of medicines, f odder, firewood, human food and they protect their croplands against wind and water erosion. *Faidherbia albida* and *Acacia tortilis* constitutes the main fodder woody legume plant in the commune. They are also source of firewood and timber. *Acacia senegalandAcacia seyal* provides natural gum to the commune. For instance, the leaves of *Vignaunguiculata*are consumed as salad in the commune.*Arachishypogaea* and *Vignaunguiculata* are the main cash legume crops in the commune.

IV. CONCLUSION

The parklands of the commune of Mayahi are floristically diverse in legume species. The inventoried flora has 55 legume species belonging to 24 genera and 3 legume botanical families Fabaceae are the best represented among the legume botanical families in the parklands of the commune of Mayahi. Structural analysis revealed that the woody legume flora health is good state but the woody legume flora is under pressure due to human activities. The socio-economic analysis showed that the legume flora provides a myriad of services to the people of Mayahi.

The study recommends further study that will examine the impact of anthropogenic activities on the legume flora of the commune of Mayahi.

V. ACKNOWLEDGEMENTS

Authors are grateful to the rural population of the commune of Mayahi mainly the head of the villages who gave us the accommodation during our stay in their different villages**.** Special thanksgo to captain Traoré Lamine the director of environment of the commune of Mayahi for thesupport during our stay in Mayahi commune. Our sincere acknowledgments go to the UniversityDan Dicko Dankoulodo of Maradi, Niger mainly to the professors Saadou Mahamane and Ali Mahamane who provided the financial and botanical assistances to carry out the study.

LEGUME FLORISTIC LIST

	Species	**Families**
1	*Crotalaria podocarpa* DC.	Fabaceae
2	*Aeschynomene indica* L.	Fabaceae
3	*Alysicarpus ovalifolius* (Schum. Et Thonn.)	Fabaceae
4	*Arachis hypogaea* L.	Fabaceae
5	*Canavalia rosea* (L.) DC.	Fabaceae
6	*Crotalaria goreensis* Guill. & Perr.	Fabaceae
7	*Crotalaria retusa* L.	Fabaceae
8	*Crotalaria senegalensis* (Pers.) Bak. Ex.DC.	Fabaceae
9	*Indigofera astragalina* Dc.	Fabaceae

10	*Indigofera berhautiana* Gillet.	Fabaceae
11	*Indigofera bracteolata* DC.	Fabaceae
12	*Indigofera dendroides* Jacq.	Fabaceae
13	*Indigofera diphylla* Vent.	Fabaceae
14	*Indigofera hirsuta* Var.*hirsuta*	Fabaceae
15	*Indigofera nummulariifolia* (L.) Liv. ex Alston	Fabaceae
16	*Indigofera pilosa*Poir.	Fabaceae
17	*Indigofera stenophylla* Guill. & Perr.	Fabaceae
18	*Indigofera tinctoria* L.	Fabaceae
19	*Sesbania pachycarpa* DC.	Fabaceae
20	*Stylosanthes erecta*P.Beauv.	Fabaceae
21	*Tephrosia bracteolata* Guill. & Perr.	Fabaceae
22	*Tephrosia linearis* (Willd.) Pers.	Fabaceae
23	*Tephrosia lupunifoli*a DC.	Fabaceae
24	*Tephrosia obcordata* (Lam.exPoir.)	Fabaceae
25	*Tephrosia purpurea* (L.) Pers.ssp. *Leptostachya*	Fabaceae
26	*Vigna unguiculata* (L.) Walp.	Fabaceae
27	*Voandzeia subterranea* (Thouars (L.)) Verdec.	Fabaceae
28	*Zornia glochidiata*Reichb.ex DC.	Fabaceae
29	*Bauhinia rufescens* Lam.	Caesalpiniaceae
30	*Cassia absus* L.	Caesalpiniaceae
31	*Cassia italica* (Mill.) Lam. Ex Fw.Andr	Caesalpiniaceae
32	*Cassia mimosoides* L.	Caesalpiniaceae
33	*Cassia nigricans*Vahl.	Caesalpiniaceae
34	*Cassia obtusifolia* L.	Caesalpiniaceae
35	*Cassia occidentalis* L.	Caesalpiniaceae
36	*Cassia siamea* L.	Caesalpiniaceae
37	*Cassia sieberiana* DC.	Caesalpiniaceae
38	*Cassia singueana* Del.	Caesalpiniaceae
39	*Delonix regia* (Hook.) Raf.	Caesalpiniaceae
40	*Parkinsonia aculeata* L.	Caesalpiniaceae
41	*Piliostigma reticulatum* (DC.) Hochst	Caesalpiniaceae
42	*Tamarindus indica* L.	Caesalpiniaceae
43	*Acacia ataxacantha* DC.	Mimosaceae
44	*Acacia nilotica* (L.) Willd. Ex Del.subsp.*nilotica*	Mimosaceae
45	*Acacia senegal* (L.) Willd.	Mimosaceae
46	*Acacia seyal* Del.	Mimosaceae
47	*Acacia sieberiana* DC.	Mimosaceae
48	*Acacia tortilis* Subsp.*raddiana*	Mimosaceae
49	*Albizia chevalieri* Harms.	Mimosaceae
50	*Albizia lebbeck* (L.) Benth.	Mimosaceae
51	*Dichrostachys cinerea* (L.) Wight &Arn.	Mimosaceae
52	*Faidherbia albida* Del.	Mimosaceae

53	*Prosopis africana* (Guill. & Perr.) Taub.	Mimosaceae
54	*Prosopis juliflora* (SW) DC.	Mimosaceae
55	*Entada africana* Guill. & Perr	Mimosaceae

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