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Diversity and floristic composition of woody plants in traditional agrosystems of sudano-sahelian zone of Cameroon: case of Meri in the Mandara Mountains

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Abstract: Sudano-Sahelian domain is the poorest in biodiversity because of the climate which is unfavourable compared to the equatorial climate. The unsustainable agricultural practices associated with this climatic roughness are among the main factors of habitat destruction, hence the destruction of biodiversity in this phytogeographic environment. In order to valorize and conserve sudano-sahelian plant resources, a study was carried out in seasonal agrosystems in the Mandara Mountains. The Diversity and the floristic diversity were assessed. Inventories of woody plants were done in 16 plots (100 m x 100 m) grouped in 4 localities/villages. The circumference of the trunk of all the inventoried plants (circonference ≥ 10 cm) was measured. In total, 64 species grouped 45 genera and 27 families were inventoried. The highest FIV was obtained for Mimosaceae (FIV = 104.51) and Combretaceae (FIV = 51.22), the other families had FIV < 30. Diversities in the localities (Shannon index ranging from 2.82 to 2.86 bits) were lower than diversity in whole stand (Shannon index = 3.09 bits). *Acacia albida* (IVI = 53.52, RI = 6.25), *Acacia nilotica* (IVI = 9.18, RI = 18.75), *Acacia seyal* (IVI = 5.19, RI = 43.75), *Anogeissus leiocarpus* (IVI) = 41.82, RI = 0), *Balanites aegyptiaca* (IVI = 14.23, RI = 12.50), *Diospyros mespiliformis* (IVI = 9.91, RI = 37.50), *Tamarindus indica* (IVI = 16.35, RI = 12.5), and *Ziziphus mauritiana* (IVI = 9.52, RI = 31.25) were observed in all localities. There were considered as characteristics and represent the floristic background of the stand. Traditional agrosystems can be considered as tools for the conservation of wild species useful to local populations. It would be imperative to conserve in situ wild species, source of genetic diversity for their sustainable use.

Keywords: *floristic background, floristic composition, Mandara Mountains, sustainable use, traditional agrosystems.*

Introduction

Anthropogenic actions are the deterministic factors that cause the destruction of biodiversity. These anthropogenic actions are habitat destruction, overexploitation of species or habitats, pollution and introduction of invasive species (Bergonzini, 2004). Their consequences are more severe in Sahelian environments. The Cameroonian Sahelian domain is in north of the Sudanese domain. It is the driest of the phytogeographical domains and the poorest in biodiversity (Letouzey, 1985) because of the climate which is unfavourable compared to the equatorial climate. The unsustainable agricultural practices associated with this climatic roughness are among the main factors of habitat destruction, hence the destruction of biodiversity in this phytogeographic environment (Fondoum, 2001).

Numerous wild plant species are used in various ways by local populations for food and medicinal purposes and so on (Mapongmetsem *et al*., 1997, 2002; Todou *et al*., 2017a). Some are called multipurpose plants because only one species can be used for more than one output. However, the inappropriate exploitation and overexploitation of phytodiversity components do not ensure the sustainable use of these resources and lead to their disappearance (Thanam, 1990; Thakur, 1997; Mapongmetsem, 2002). One of the solutions to this problem is the integration of wild plants into agrosystems (Tchoundjeu *et al*., 1998). In the Congo-Guinean phytogeographical region in Cameroon, several plant species such as *Dacryodes edulis* and *Elaeis guineensis* were successfully introduced in peasant agrosystems (Todou, 2015). Conscious of the degradation of wild phytodiversity, some research centers, like ICRAF (International Centre for Research in Agroforestry) and IRAD (Institut de Recherche Agricole pour le Développement), have identified wild African forest species that are candidates for domestication through agroforestry, within *Tree Domestication Program* (Leakey & Simons 1998). In the Sudano-zambezian region, only technical data sheets and more or less general works exist on the species useful to the populations (Gautier *et al*., 2002). It would be wise to conduct a participatory study to identify wild species used by local populations and to develop effective strategies for their integration into agrosystems and their sustainable uses. Although the traditional agroforestry practices contribute immensely to food security, traditional medicine, fodder and environmental protection.

The Sahelian climate regime imposes a seasonal agricultural system of three to four months and the conventional agroforestry system is still poorly known. This agricultural system is characterized by the cultivation of annual species (sorghum, peanuts, millet, cotton, voandzou, cowpea, etc.) and the felling of wild trees. However, increasingly local people are becoming aware of protecting appreciated wild pant species in their agrosystems (Levesseur & Olivier, 2000). Beside these seasonal agrosystems, permanent riverside gardens where many introduced woody plants (mango, guava, cashew, lemon, neem, eucalyptus, etc.) (Seignobos, 2014) are observed in this phytogeographic area.

This study was conducted in a context where increasing of cultivated lands, the degradation of natural ecosystems (Girard, 2002; Jayne, 2014) and the increasing willingness of populations for using wild plants (Todou *et al*., 2017a) are important. The poor knowledge of the diversity of protected wild plants in the agrosystems by the populations makes difficult to develop the policy of agroforestry with native species. It is urgent to know the wild species protected and planted by the populations in their agrosystems for optimizing their sustainable uses and to consider their integration in conventional agroforestry.

The main objective of this study is to contribute to the valorization of the Sudano-Sahelian phytogenetic resources for their conservation and their sustainable use. Specifically, it is to (i) determine the floristic composition and taxonomic richness, (ii) assess the stand diversity indexes and (iii) understand the ecological importance of plant species for study area

Materials and methods

Study site

The current research study has been carried out at Meri, an administrative Subdivision located in the Sudano-sahelian zone of Cameroon. Its cover about 460 km² with 87000 inhabitants (PNDP, 2016). Meri is bordered in the north by Tokombéré, in the west by Soulede-Roua, in the south by Gazawa and Mokolo and in the east by Maroua (PNDP, 2016).

The climate is characterized by eight months of dry season (October to May) and four months of rainy season. Rainfall varies between 600 and 900 mm per year and the average annual temperature is 27 °C with a maximum of 38 °C (in April) and a minimum of 18 °C (in December and January) (Suchel, 1987; Ddader-D, 2012).

Vegetation is characterized by shrub and spiny steppes (Letouzey 1985). The characteristic woody plant species include *Anogeissus leiocarpus, Boswellia dalzielii, Balanites aegyptiaca, Acacia albida, Acacia nilotica, Ziziphus* spp. and *Combretum* spp.

The most dominant ethnic groups are Mufu, Guiziga, and Fulbe. However, there are poorly represented ethnic groups such as Mafa, Kapsiki, Moundang, Toupouri. These populations practice mainly small ruminant livestock and rainy season food crops.

To represent the whole extent of Meri, data collection was done in four localities (Figure 1). There were chosen according to the orientation of the cardinal points (Doulek in the north, Kalliao in the south, Mbozo in the south-east and Godola in the west).

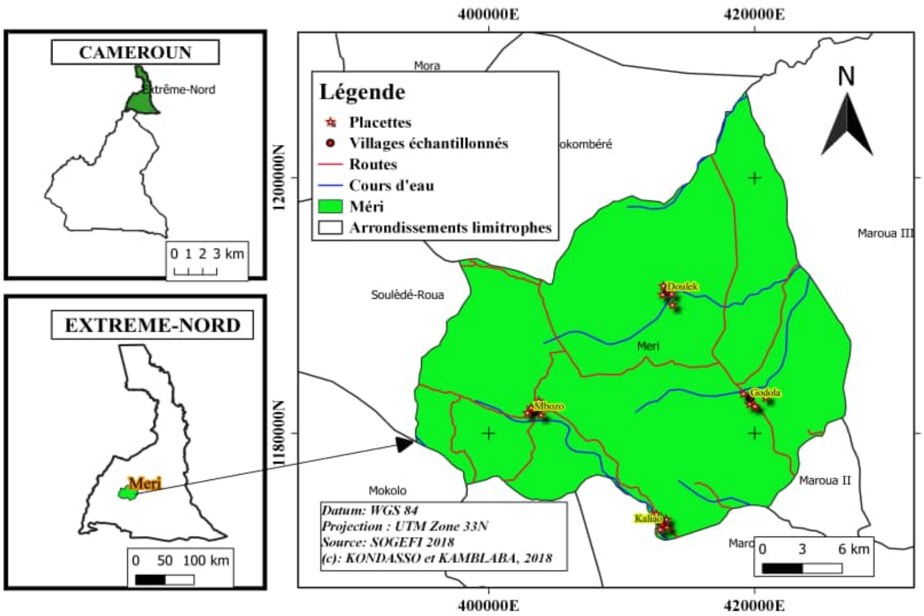

Figure 1. Location of study area

Data collection

Traditional agrosystems in sudano-sahelian zone are characterized by the cultivation of annual plants, following the rhythm of the seasons. In most cases, farmers protect wild woody plants in their fields for multiple uses (Todou et al. 2019). The current data were collected in traditional agrosystems from May to August 2018. This is the rainy season, therefore the cropping season. The data collection and analysis system were inspired by the methodologies developed by Maître (1986), van Rompaey (1993) and Condit (1995). In total, 16 plots of 100 m x 100 m (= 16 ha) were set up for four plots per locality. Each plot was subdivided into five transects of 100 m x 20 m. Only woody individuals with trunk circumference greater than or equal to 10 cm were systematically inventoried. Tree circumferences were taken at high breast (1.30 m) using graduated tape (Wala, 2004). For stems less than a meter height, measurements were made at 30 cm from the ground (Henry et al., 2009; Jiagho et al., 2016). For multi-stem plants, the average circumference was calculated using the formula used by Kobore et al. (2003) and Todou et al. (2017b):

$$\mathrm{Cm} = \sqrt{\sum_{t=1}^{n}(C_i^2)}, \quad (1)$$

where C_i is the circumference of stem i.

Scientific names of the most common species were done directly in the field whenever possible. Some specimens were collected to authenticate scientific names in laboratory of Agriculture and Development Research Institute (IRAD) in Maroua.

Data analysis

Statistics for Social Science software version 20.0 (SPSS, Inc., Chicago, USA) and Excel (Microsoft Office 2013) were used for data processing and analysis and presentation of results.

Floristic composition of woody plants in traditionnal agrosystems

All floristic data were recorded and grouped together. Abundance of families and abundance of species were calculated. In addition, the number of species belonging to the genera was also calculated.

The relative specific abundances of each species were calculated according to the formula of Curtis & Mcintosh (1951).

$$\mathrm{RA} = (\mathrm{Ni}/\mathrm{Nt}) \times 100, \quad (2)$$

where Ni is the number of individuals belonging to the species i and Nt is the total number of individuals of all species. Stand richness was calculated using the formula used by Guedjé (2002):

$$\mathrm{SR} = \mathrm{Nt}/\mathrm{S}, \quad (3)$$

where Nt is the total number of individuals of all species and S is the total number of species.

The densities (D) of each species were calculated according to the formula

$$\mathrm{Di} = \mathrm{Ni}/\mathrm{A}$$

where Ni is the number of stems belonging to species i and A is the area surveyed in hectare. It is expressed in number of individuals per hectare.

Specific diversity

The diversity was described using the widely employed indexes to measure biological diversity (Maguran, 2004).

The Shannon index was choosing to describe stand diversity. This choice assumed that all species are represented in the sample and are randomly sampled. It was calculated for each locality (diversity α) and for the whole Méri stand (diversity γ). It was calculated according to Shannon's formula:

$$H = -\sum_{i=1}^{s} (\mathrm{pi} * \ln(\mathrm{pi})), \quad (4)$$

where Pi (=ni/Nt) is the relative frequency of species i; Nt is the total number of individuals of all species. If $H \leq 3$, the diversity is low; if $3 < H \leq 4$, the diversity is moderate and if $H > 4$, the diversity is high (Yedomonhan, 2009).

Species evenness is a diversity index, a measure of biodiversity, which is used to measure the homogeneous distribution of tree species in the sample plot (Krebs, 1999). It is described:

$$\mathrm{E} = \frac{\mathrm{H'}}{\mathrm{Hmax}} = \frac{\mathrm{H'}}{\mathrm{lns}} \quad (5)$$

Where: E = Evenness, H' = Calculated Shannon-Wiener diversity, $H_{max} = ln(s)$ = species diversity under maximum equitability conditions and S = the number of species

Similarity index expressed the diversity ß. It was estimated using Sorenson's coefficient (Sorenson, 1948). It allowed to compare the floristic composition of the localities. The formula used is:

$$S_{or} = \left(\frac{2S1,1}{2S1,1+S1,0+S0,1}\right) \text{ x } 100, \quad (6)$$

where S_{or} = Sorenson's index; $S_{1,1}$ = the number of species observed in the two localities; $S_{1,0}$ = the number of species observed in the first locality and not in the second; $S_{0,1}$ = number of species observed in the second locality and not in first.

Woody species rarity in the site

The rarity index made it possible to determine the rarity of the species encountered. It is obtained from the equation of Géhu and Géhu (1980) and Kokou *et al*., (2005) according to the following formula:

$$RI = (Pi/Pt) \text{ x } 100, \quad (7)$$

where *Pi* is number of plots where species *i* is found and *Pt* is the total number of plots arranged in the study site. Species with a rarity index below 80% were considered as very frequent and abundant. Those with rarity index greater than 80% were considered as rare (Traoré *et al*, 2011). A rarity index of 100% means that the presence of the species was not observed anywhere, and that this species was considered as highly endangered in the site.

The Importance Value Index (IVI) and Family Importance Value (FIV) were calculated (Pascal, 1988) to characterize the ecological importance of woody species and families within vegetation in the traditional agrosystems of Meri.

Results and discussion

Floristic richness and minimal area

A total of 843 individuals grouped in 64 species, 45 genera and 27 families were inventoried and measured in 16 ha. The families/species ratio was 0.42, the families/genera ratio was 0.60 and the genera/species ratio was 0.70. The number of species was higher than that found by Ndong *et al* (2015) who identified 38 woody species in the same area in Senegal. Numerical differences reflect ecological differences and differences in ethnocultural habits. However, Fondoun (2001) identified 60 local species and introduced species into a permanent garden in Mouda (in Far-North of Cameroon). In non-cultivated plain of Moutourwa (in the Far-North of Cameroon), 75 species, 54 genera and 28 families were inventoried with families/species ration = 0.37; families/genera ratio = 0.52 and genera/species ratio = 0.72 (Todou *et al*., 2016). These ratios were respectively 0.34; 0.50 and 0.69 in sudanian forest of Sena Oura National Park (Todou *et al*. 2017b).

The species accumulation curve was traced for measuring the floristic representativeness of a botanical survey. The trend of the species accumulation curve followed by a natural logarithmic function ($y = 21.71 \ln(x) + 0.63$, $R^2 = 0.92$). According to Lamprecht (1989) and Williamson (2001), the minimum representing area was reached when the increase in the number of species is 10% while the sample is enlarged in size by 10%. Then, in this study, the curve became flatter and it was almost reaching an asymptote at 14 ha which represented the minimal area (Figure 2).

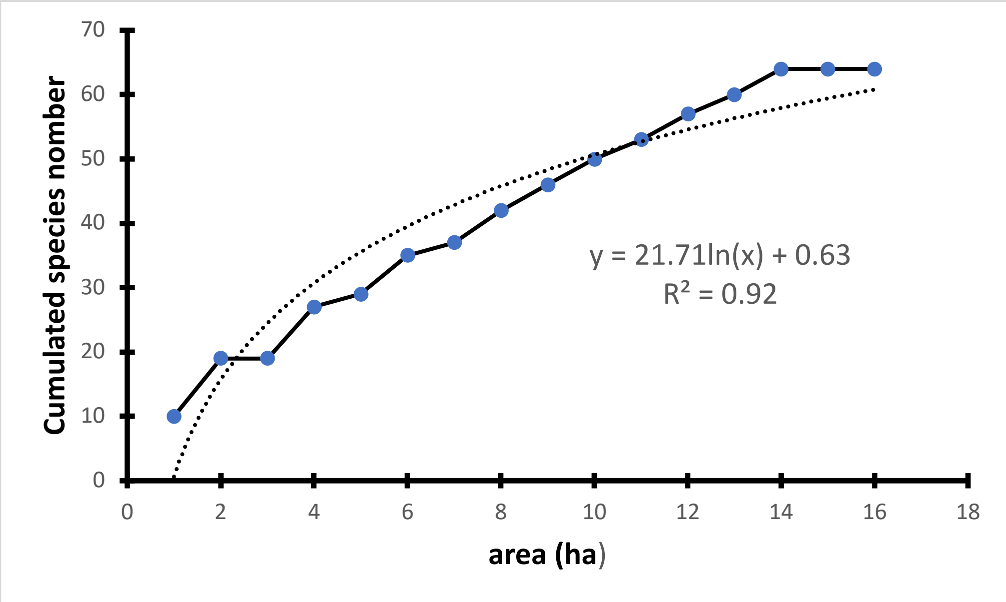

Figure 2. Species accumulation curve

Families' taxonomic richness and Family Importance Values

The most abundant families include *Mimosaceae* (230 individuals, 9 species), *Combretaceae* (136 individuals, 7 species), *Ceasalpiniaceae* (54 individuals, 7 species), *Euphorbiaceae* (23 individuals, 5 species), *Anacardiaceae* (92 individuals, 4 species) and *Balanitaceae* (49 individuals, 1 species). They represented 89.43% of the recorded stems and 51.56% of the identified species. Family Importance Values ranged from 0.23 to 104.51. The highest FIV was obtained for Mimosaceae (FIV = 104.51), *Combretaceae* (FIV = 51.22), *Anacardiaceae* (FIV = 29.82) and *Balanitaceae* (FIV = 20.61), which represent 206.61% of total FIV in the study area. On a genus level, the best represented families were *Ceasalpiniaceae* (5 genera), *Euphorbiaceae* (4 genera), *Combretaceae* (3 genera), *Anacardiaceae* (3 genera). *Asclepiadaceae*, *Burseraceae*, *Capparaceae*, *Fabaceae*, *Meliaceae* and *Rubiaceae* were represented by two genera. About 16 families were represented by only one genus (Table 1; Appendix 1).

Table 1. Richness and index values of the most abundant families (FIV > 10)

Families	AF	S	G	G/S	FIV
Anacardiaceae	92	4	3	0.75	29.82
Balanitaceae	49	1	1	1	20.60
Burseraceae	37	3	2	0.67	11.78
Caesalpiniaceae	54	7	5	0.71	15.07
Combretaceae	136	7	3	0.43	51.22
Meliaceae	61	2	2	1	20.46
Mimosaceae	230	9	2	0.22	104.50
Rhamnaceae	46	2	1	0.5	11.89

AF = abundance of Families; G = number of genera; S = number of species; G/S = (number of genera)/(number of species)

Density and specific diversity

The densities in the localities varied from 43.5 to 67 stems per hectare. The heaviest locality was Godola (D = 67) while Kallio locality had the least density (D = 43.5). The total stand density was 52.68 individuals per hectare (Table 2). The densest species were *Acacia albida* (D = 10.37), *Anogeissus leiocarpus* (D = 6.68), *Balanites aegyptiaca* (D = 3.06), *Tamarindus indica* (D = 2.25) and *Zyzyphus mauritiana* (D = 2.37).

The species richness varied from 27 species in Kalliao locality to 36 species in Doulek locality. But the number of species for the whole stand was 64. The Shannon index also varied from one locality to another. It was 2.60 bits for Kalliao locality. The Godola, Doulek and Mbozo localities had their Shannon clues almost the same (ranging from 2.82 to 2.86 bits). However, the Shannon diversity index of the whole stand (SH = 3.09 bits) showed that the diversity γ remains moderate. Diversities in the localities (diversity α) were lower than diversity in whole stand (diversity ɤ). This was especially true since the species richness of the localities (ranging from 27 to 36 species) was smaller than those of the whole stand (64 species). The Stand richness ranged from 5.41 in Doulek locality to 7.53 in Godola locality. It was 13.17 for whole stand (Table 2).

The similarity index between localities were average (between 50.7 and 57%) indicating a relative dominance of some species (Table 3). It is higher between Godola and Mbozo localities (Sor = 57%) and least between Doulek and Mbozo localities (Sor = 50.74%). It was important to remember that Todou *et al*. (2016; 2017b) considered the moderate values of the Shannon index as sufficient for the Sudanese and Sahelian ecosystems. In equatorial ecosystems diversity is higher. In Bipindi-Akom II, southern Cameroon, Guedjé (2002) found S = 199, D = 629 individuals per hectare, SH = 5.55 bits, SR = 12.6.

The low level of diversity in localities comparative to the diversity of whole stand showed that farmers only protect the plants they know and that they consider as useful. They protect wild plants in their agrosystems for food, for traditional medicine or for firewood. In addition, knowledge of plants varies from one ecological zone to another, from one community to another, from one ethnic group to another, and therefore from one locality to another.

Table 2. Diversity indices

Diversity parameters	Kallio	Godola	Doulek	Mbozo	All stand
Number of individuals (N)	174	267	195	207	843
Specific richeness (S)	27	35	36	31	64
Stand richness (SR)	6.44	7.53	5.41	6.67	13.17
Densité (D)	43.50	67	48.75	51.75	52.68
Shannon index (SH)	2.60	2.86	2.82	2.86	3.09
Equitability of Piélou (EQ)	0.79	0.88	0.78	0.83	0.74

Table 3. Similarity between localities (in %)

	Godola	Douleek	Kalliao	Mbozo
GODOLA	100			
DOULEK	53.52	100		
KALLIO	54.83	53.96	100	
MBOZO	57.57	50.74	57.17	100

Abundance and Rarity index of species

Only five domesticated species were found and about 59 were wild species. The most abundant and dominant species in the stand were *Acacia albida* (RA = 19.69%, BA = 84.49 m²/ha), *Anogeissus leiocarpus* (RA = 12.69%, BA = 35.10). m²/ha), *Sclercarya birrea* (RA = 7.59%, BA = 12.56 m²/ha), *Azadirachta indica* (RA = 7.11%, BA = 11.03 m²/ha) and *Balanites aegyptiaca* (RA = 5.81%, BA = 7.36 m²/ha). These five species are trees and they represented about 53% of woody plants in the stand (Table 4). The most represented species in non-cultivated plain of Moutourwa included the shrubs: *Piliostigma reticulatum*, *Annona senegalensis* and *Hexalobus monopetalus* (Todou *et al.* 2016).

Examination of the rarity index of the species showed that 40 species had a rarity index greater than 80%. They were considered as rare in the study site. The other 24 species (RI ≤ 80%) were considered as frequent. *Anageissus leiocarpus* were found in all 16 plots and had a rarity index equal to zero (RI = 0). Two species *Sarcocephalus latifolius* and *Boscia anguistifolia* were found only in Mbozo locality whereas *Combretum molle* and *Prosopis africana* were found only in Doulek locality.

Characteristic stand species were those with high Importance Value Index and low rarity index. In this study, the so-called characteristic species representing the floristic background of the stand were those with Importance Value Index greater than or equal to 5% and a rarity index less than 50% (IVI ≥ 5 and RI ≤ 50). Eight species were considered here as characteristics and represent the floristic background of the stand. They included *Acacia albida* (IVI = 53.52, RI = 6.25), *Acacia nilotica* (IVI = 9.18, RI = 18.75), *Acacia seyal* (IVI = 5.19, RI = 43.75), *Anogeissus leiocarpus* (IVI) = 41.82, RI = 0), *Balanites aegyptiaca* (IVI = 14.23, RI = 12.50), *Dyospiros mespiliformis* (IVI = 9.91, RI = 37.50), *Tamarindus indica* (IVI = 16.35, RI = 12.5), and *Zyzyphus mauritiana* (IVI = 9.52, RI = 31.25). They alone accounted for about 158.72% of total IVI of all species (Table 4, Appendix 2). These eight species were observed in all localities and almost in all plots. They were the characteristic species of the whole stand and thus formed the common floristic background of the stand. They were intentionally protected by farmers except for *Acacia albida* and *Acacia nilotica* which are species mostly planted by the people because they are recommended by SODECOTON and the Ministry in charge of agriculture for their fertilizing power. *Balanites aegyptiaca, Dyospiros mespiliformis, Tamarindus indica* and *Zyzyphus mauritiana* are wild fruit trees cited among the best fruit trees in northern Cameroon (Mapongmetsem *et al*., 2012, Todou *et al.,* 2017a). In this study, nearly 30% were fruit trees.

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Table 4. Importance values index and rarity index of most abundant species (IVI > 10)

Families	Scientific names	Status	RA	DI	BA (m²/ha)	IVI	RI
Anacardiaceae	*Lannea microcarpa**	W	2.84	1.50	1.76	10.10	68.75
	*Sclerocarya birrea**	W	7.59	4	12.56	23.20	93.75
Balanitaceae	*Balanites aegyptiaca**	W	5.81	3.06	7.36	14.24	12.5
Burseraceae	*Boswellia dalzielii*	W	2.61	1.38	1.48	10.03	56.25
	*Tamarindus indica**	W	4.27	2.25	3.97	16.35	12.5
Combretaceae	*Anogeissus leiocarpus*	W	12.69	6.68	35.10	41.82	0
Ebenaceae	*Diospyros mespiliformis**	W	3.20	1.69	2.23	9.91	37.50
Meliaceae	*Azadirachta indica*	D	7.12	3.75	11.03	16.85	81.25
Mimosaceae	*Acacia albida*	W	19.69	10.37	84.49	53.53	6.25
Moraceae	*Ficus ingens**	W	1.54	0.81	0.51	12.89	62.5

*Ni = abundance of species i; Di = density (trees/ha); IVI = Importance Values Index; BA = basal area; RI = Rarity Index; D = domesticated; W = wild; * = fruit*

Conclusion

The present study revealed an awareness by rural populations to integrate wild into their agrosystems. It revealed significant woody diversity and a density of more than 50 individuals per hectare in seasonal agrosystems in Sahelian Cameroonian environments. Specific diversity is greater than local diversities reflecting the ethnologic differences. Eight species were considered as characteristics and represent the floristic background of the stand. The Importance Value Index greater than or equal to 5% and a rarity index less than 50%. Nearly 30% were fruit trees, four of which (*B. aegyptiaca, D. mespiliformis, T. indica and Z. mauritiana*) were among the characteristic species, representing the floristic background of the stand. Protected wild woody species in agrosystems in the Sahelian zones of Cameroon would be multipurpose and used by the local populations in food, traditional medicine, firewood or fodder.

The results of this study contribute to the valorization of the Sudano-Sahelian phytogenetic resources for their conservation and their sustainable use. An ethnobotanical study is under way to understand the motivation of populations to conserve wild woody plants in their fields to optimize effective conservation strategies and sustainable use.

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Appendix 1: Families richness and Family Index Value

Families	AF	S	G	G/S	FIV
Anacardiaceae	92	4	3	0.75	29.82
Annonaceae	1	1	1	1	0.23
Apiaceae	1	1	1	1	0.23
Arecaceae	2	1	1	1	0.46
Asclepiadaceae	3	2	2	1	0.70
Balanitaceae	49	1	1	1	20.60
Bignoniaceae	8	1	1	1	2.09
Bombacaceae	1	1	1	1	0.23
Burseraceae	37	3	2	0.67	11.78
Caesalpiniaceae	54	7	5	0.71	15.07
Capparaceae	2	2	2	1	0.47
Combretaceae	136	7	3	0.43	51.22
Ebenaceae	27	1	1	1	7.6
Euphorbiaceae	23	5	4	0.8	5.62
Fabaceae	8	2	2	1	1.96
Meliaceae	61	2	2	1	20.46
Mimosaceae	230	9	2	0.22	104.50
Moraceae	36	3	1	0.33	6.65
Moringaceae	6	1	1	1	1.47
Olacaceae	1	1	1	1	0.23
Rhamnaceae	46	2	1	0.5	11.89
Rubiaceae	4	2	2	1	0.95
Sapotaceae	5	1	1	1	1.21
Sterculiaceae	6	1	1	1	1.47
Tilliaceae	1	1	1	1	0.23
Ulmaceae	5	1	1	1	1.20
Verbenaceae	8	1	1	1	1.98
Total (27 Families)	843	64	45	0.70	300

AF = abundance of Families; G = number of genera; S = number of species; G/S = (number of genera)/(number of species)

Appendix 2: Importance values index and rarity index of most abundant species

Families	Scientific names	Status	RA	Di	BA (m²/ha)	IVI	RI
Anacardiaceae	*Anacardium occidentalis**	D	0.12	0.06	0.003	0.25	93.75
	*Lannea fruticosa**	W	0.35	0.19	0.02	0.75	93.75
	*Lannea microcarpa**	W	2.84	1.50	1.76	10.10	68.75
	*Sclerocarya birrea**	W	7.59	4	12.56	23.20	93.75
Annonaceae	*Annona senegalensis**	W	0.12	0.06	0.003	0.25	93.75
Apiaceae	*Steganotaenia araliacea*	W	0.12	0.06	0.003	0.27	81.25
Arecaceae	*Hyphaene thebaica**	D	0.24	0.12	0.01	0.59	93.75
Asclepiadaceae	*Calotropis procera*	W	0.24	0.13	0.01	0.50	87.50
	*Leptadenia hastata**	W	0.12	0.06	0.003	0.25	93.75
Balanitaceae	*Balanites aegyptiaca**	W	5.81	3.06	7.36	14.24	12.5
Bignoniaceae	*Stereospermum kunthianum*	W	0.95	0.50	0.19	2.08	12.5
Bombacaceae	*Bombax costatum*	W	0.12	0.06	0.003	0.67	93.75
Burseraceae	*Boswellia dalzielii*	W	2.61	1.38	1.48	10.03	56.25
	Commiphora africana	W	1.66	0.88	0.60	3.45	62.5
	Commiphora kerstingii	W	0.12	0.06	0.003	0.38	93.75
Caesalpiniaceae	*Afzelia africana*	W	0.24	0.12	0.01	0.49	93.75
	Bauhinia rufescens	W	0.12	0.06	0.003	0.25	93.75

	Cassia sieberiana	W	0.47	0.25	0.04	0.96	81.25
	Cassia siemea	D	0.24	0.12	0.01	0.65	93.75
	Piliostigma reticulatum	W	0.59	0.31	0.07	1.34	87.50
	Piliostigma thoningii	W	0.47	0.25	0.04	1.100	81.25
	*Tamarindus indica**	W	4.27	2.25	3.97	16.35	12.5
Capparaceae	*Boscia angustifolia*	W	0.12	0.06	0.003	0.27	93.75
	Capparis sepiaria	W	0.12	0.06	0.003	0.24	93.75
Combretaceae	*Anogeissus leiocarpus*	W	12.69	6.68	35.10	41.82	0
	Combretum aculeatum	W	0.24	0.13	0.01	0.49	87.50
	Combretum collinum	W	0.12	0.06	0.003	0.25	93.75
	Combretum fragrans	W	1.66	0.87	0.60	4.72	56.25
	Combretum glutinosum	W	1.18	0.62	0.30	3.12	62.50
	Combretum molle	W	0.12	0.06	0.003	0.34	93.75
	Terminalia brownii	W	0.12	0.06	0.003	0.25	93.75
Ebenaceae	*Diospyros mespiliformis**	W	3.20	1.69	2.23	9.91	37.50
Euphorbiaceae	*Jatropha curcas*	W	0.35	0.19	0.02	0.73	81.25
	Euphorbia poissoni	W	1.06	0.56	0.24	2.32	87.50
	Flueggea virosa	W	0.47	0.25	0.04	0.98	75
	Jatropha gossypifolia	W	0.71	0.37	0.11	1.45	87.5
	Manihot esculantus	D	0.12	0.06	0.003	0.25	93.75

Fabaceae	*Dalbergia melanoxylon*	W	0.12	0.06	0.003	0.25	93.75
	Pterocarpus erenaceus	W	0.83	0.44	0.15	4.36	87.5
Meliaceae	*Azadirachta indica*	D	7.12	3.75	11.03	16.85	81.25
	Khaya senegalensis	W	0.12	0.063	0.003	0.88	93.75
Mimosaceae	*Acacia albida*	W	19.69	10.37	84.49	53.53	6.25
	Acacia ataxacantha	W	0.12	0.06	0.003	0.25	93.75
	Acacia micronata	W	0.12	0.06	0.003	0.24	93.75
	Acacia negritiana	W	0.12	0.06	0.003	0.24	93.75
	Acacia nilotica	W	4.39	2.31	4.19	9.18	18.75
	Acacia polyacantha	W	0.59	0.31	0.07	1.21	75
	Acacia senegal	W	0.12	0.06	0.003	0.24	93.75
	Acacia seyal	W	2.01	1.06	0.88	5.19	43.75
	Prosopis africana	W	0.12	0.06	0.003	0.39	93.75
Moraceae	*Ficus ingens**	W	1.54	0.81	0.51	12.89	62.5
	*Ficus platyphylla**	W	0.24	0.12	0.01	1.29	87.5
	*Ficus sycomorus**	W	1.30	0.69	0.37	8.71	75
Moringaceae	*Moringa oleifera*	D	0.71	0.37	0.11	1.44	93.75
Olacaceae	*Ximenia americana**	W	0.12	0.06	0.003	0.24	93.75
Rhamnaceae	*Ziziphus mauritiana**	W	4.51	2.37	4.42	9.52	31.25
	*Ziziphus spina-christi**	W	0.95	0.50	0.19	2.06	87.5

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Rubiaceae	*Feretia apondenthera*	W	0.35	0.19	0.02	0.72	87.5
	Sarcocephalus latifolius	W	0.12	0.06	0.003	0.27	93.75
Sapotaceae	*Vitellaria paradoxa**	W	0.59	0.31	0.07	2.99	87.5
Sterculiaceae	*Sterculia setigera*	W	0.71	0.37	0.11	3.03	87.5
Tilliaceae	*Grewia flavescens*	W	0.12	0.06	0.003	0.27	93.75
Ulmaceae	*Celtis integrifolia*	W	0.59	0.31	0.07	4.39	81.25
Verbenaceae	*Vitex doniana**	W	0.95	0.50	0.19	2.66	87.5
	Total		843	52.68	173.73	300	-

*Ni = abundance of species i; Di = density (trees/ha); IVI = Importance Values Index; BA = basal area; RI = Rarity Index; D = domesticated; W = wild; * = fruit*