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RESEARCH ARTICLE

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Traditional agroforestry systems and biodiversity conservation in Tandjile East, Chad

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ABSTRACT

The daily increase in human activities due to population explosion is a great threat to biodiversity conservation. Man is using land, water and natural resources more than ever before. In view of this, the main objective of the present study is to evaluate the contribution of the traditional agroforestry systems to environmental and biodiversity conservation. In the Tandjile East, farmers generally associate exotic and native trees in their farming systems; studies on their floristic composition are scarce. The actual investigations were carried out in three main land use systems (home gardens, parklands, natural savannahs) and three ethno-linguistic groups (Gama, Goulaye and Gabri) were involved. Floristic surveys were carried out in plots measuring 50 x 50 m^2. All the woody species were sampled; their diameter at breast height (dbh) and their height were also determined. For the 45 floristic records, a total of 8.644 stems with dbh equal or more than 10cm were registered, belonging to 33species, 26 genera and 17 families. The average number of trees density was 76.83 ± 8.70 stems ha^{-1}. The contribution of the different traditional agroforestry systems in a decreasing order is 35.30 % for the natural savannahs, 32.52 for the home gardens and 32.20 for the parklands. Concerning the indigenous knowledge, the Goulaye people conserve the highest number of trees (906) in their systems than others. For the global survey, the diversity was evaluated using Shannon and Simpson indices. In all the agrosystems, socio-economic producing tree species tend to be more frequent. All the agroforestry trees were native savannah species and only mango and citrus were introduced. These species provide food, medicine, charcoal and other non timber forest products for consumption and for sale. The traditional agroforestry systems of Tandjile were found to be particularly rich in Fabaceae Mimosoideae, Fabaceae Caesalpinioideae. Topography, heterogeneity, moderate precipitations and community endogenous knowledge may all contribute to explaining the high tree diversity found. This study highlights the botanical importance of the Tandjile East region within the Chad Republic and the role of traditional agroforestry practices to support tree species richness and provides evidence of the farms' role as biodiversity reservoirs.

Key-words: Conservation, Local species, Traditional agroforestry systems, Plant diversity, NTFPs, Chad.

INTRODUCTION

The environmental protection and sustainable management of biological resources and their habitats are among priorities in international agenda since the first Earth Summit in Stockholm (Sweden) in 1972. The loss of biodiversity in natural ecosystems and consequent threat of extinction of valuable food/fruit tree crops are continuing in spite of the efforts on biodiversity conservation in various countries. A majority of these tree crops are completely interwoven with the traditional farming systems, and as such requires to be well protected. The rest of these important species are either protected wildings on the farm or lifted wildings planted in the compound farms/home gardens; deliberate planting of the fruits of these indigenous species is usually rare, while improved stock materials are not available except for certain farmers' selections which are based on phenotypic characteristics [1]. For decades, sub-Saharan African countries have been facing demographic growth to which climate changes have been added [2]. The rate of population growth is higher than food production [3]. Consequently, there is

increasing and consistent malnutrition [4]. Farmers rely on natural ecosystems to look for new lands for agriculture and harvest of non timber forest products (NTFPS) in view to solve their food, medicinal and fuel wood needs and improve their living standard [5,6]. The continuous extension of agriculture leads to increase biodiversity erosion [7]. In Chad, mainly in the Tandjile East, natural ecosystems have being modified continually due to agricultural practices dominated by slash and burn and fallow period reduction [8].

In the past, the attempt to understand conservation of biodiversity has been mostly in terms of the management of protected areas and natural forests, ignoring the possible role of land uses and the ways through which rural communities have promoted biodiversity in their subsistence agricultural production systems [9]. Traditional agroforestry has been widely promoted in the tropics as a natural resource management strategy that attempts to balance the goals of agricultural development with the conservation of biodiversity. Agroforestry systems have the advantage to allow farmers to increase their yields while at the same time protecting the environment [5,10,11]. Despite its high potential for biodiversity conservation, the traditional agroforestry systems have attracted little attention from scientists. Although traditional agroforestry systems are less diverse and less dense than natural forests [12,13]. To fill in this gap, the present study focused on the floristic diversity within traditional agroforestry systems in Tandjile. The analysis of the literature showed that data related to biodiversity conservation in these systems were scarce in the zone. It is in this perspective that the present work has been undertaken in order to involve farmers in a participatory manner in the diagnoses of the floristic diversity within their existing agroforestry systems. This initiative is in accordance with the IV and V objectives of national strategies of the poverty reduction of Chad [14] among which: the improvement of the protection of vulnerable populations and the conservation of natural ecosystems. Given the ever-increasing threats to local biodiversity in Chad, the need to study the traditional agroforestry systems has never been greater. In addition to global threats such as climate change, forest destruction for agriculture by local populations and pipeline have both heavily impacted the natural vegetation for decades.

The objectives of the study were to: assess the effect of land use systems on the biodiversity conservation in the perspective to develop appropriate strategies for a sustainable management of the region (1), determine land use systems which conserve plant diversity (2); identify the ethno-linguistic group which conserve plant diversity the most (3); record domestic and commercial uses of the most frequent species (4) and evaluate the population structure of the most frequent tree species (5).

MATERIALS AND METHODS

Site description

The Republic of Chad is situated between latitude 7th and 24th degree North and between longitude 14 th and 24th degree East. Its surface area is 1 284 000 km^2. The territory of Chad is subdivided in three bioclimatic zones among which saharian, sahelian and sudanian. The study was undertaken in the sudanian zone in which is located Tandjile East. The main cantons where investigation took place were Dono – Manga (LN: 09° 09'24,8''; LE:17° 10'11,2''; Alt:382,2m); Guidari (LN: 09° 21'10''N; LE:16° 47'38,6''; ALT: 354,9m) and Kimré (LN:09°18'08,2''; LE:16°55'32''; 355,8m). Ethno-linguistic groups involved are: Gabri, Goulaye and Gama. The climate is characterized by a rainy season (April-October) and a dry season (November – March). The mean annual precipitation varies from 700 to 800 mm and the mean monthly temperature from 27 to 36˚C [14]. Soils are essentially composed of lateritic, sand and sand-clay. The vegetation is dominated by a diversity of woody species among which *Acacia albida, Vitellaria paradoxa, Parkia biglobosa*, *Combretum* spp.; *Terminalia* spp.; *Grewia* spp. and *Gardenia* spp. are frequent in savannahs subjected to bush fires[15].

Methodology

Ethnobotanical survey

In each locality, semi - structural interviews were carried out in each group. Discussions with farmers were based on the structure of the production system, biodiversity knowledge and indigenous strategies developed locally for the conservation of biodiversity, uses of indigenous tree species as well as socio-economic factors which affect the practice of their farming system. Similar approach has been successfully used in agroforests in Cameroon [11] and in Parklands in Benin [9]. A total of 9 socio-professionals groups (men, women and children) were studied and 3 per tribe were retained. The number of persons per group varied from 12 to 26 depending on the availability of the farmers in the village. The ethno-linguistic groups involved were Gabri, Goulaye and Gama, the most representative of the region.

Floristic inventory

To describe the ecological importance of species and families within each system as well as for the total flora, the species Importance Value Index (IVI) [16] and the Family Importance Value index (FIV) [17] were also calculated:
Relative abundance = (number of individual tree of the species or family/Total number of individuals) X100;

Relative frequency (RF) = (frequency of a species / sum of all frequencies) X 100;

Relative dominance (RD) which is the ratio of the sum of the transversal basal section ($\pi D^2/4$) at 1.30m above the ground of all the individuals of the species x divided by the total basal area of all the species sampled. Total basal area of the species/total basal area of all the species X 100

Family relative diversity (FRD) = (number of species in a family /total number of species) X 100.

IVI = relative abundance + relative frequency + relative dominance:

The Family importance value index (FIV) used in Gamba forest complex in Gabon is the sum of relative density, relative basal area and relative diversity of each family [18]. FIV = number of species of family x/total number of species identified + individuals of family x/total number of individuals + sum of basal area of family x/total basal area = Family relative diversity + relative density+ relative dominance.

This approach was used successfully in evaluating tree biodiversity in Ngovayang's lowlands forest of Cameroon [19]. Despite the fact that different levels of organisations of the biodiversity exist, the present study is focused only on σ biodiversity which is intra-habitat measuring the specific diversity within a homogenous habitat.

Three common land use systems of the region are home gardens, parklands and natural savannahs were considered and evaluated. On the basis of the works done in other production ecosystems [20 ,21], an area of 50 m x 50 m was measured and explored in each of the above production systems. In each plot divided into subplots, all the tree species with more than 1.5 m height and more than 10cm of diameter were recorded[22]. A total of 45 plant lists was recorded, 15 per ethnic group and 5 per production system. The basal area of each species was determined. In addition to the diameter at the breast height (dbh) and the height of each species were determined. Also the height of the main live branch was determined.

Data processing and analysis

For the analysis of the floristic composition, species richness and diversity were calculated for the tree species in each of the land use systems using information from the sample plots. To assess species diversity Shannon and the Simpson indices were calculated for all the land use systems. Both the indices together give a good description of the alpha (within site) diversity of the land use systems [23]. ANOVA was performed and programme used is Statgraphic plus. Shannon and Simpson indices were determined using the programme R.

RESULTS AND DISCUSSION

Species richness and diversity

During the survey, a total of 8.644 stems with dbh (diameter at breast height) equal or more than 10 cm were recorded, belonging to 32 species, 26 genera and 17 families. The mean number of stems was 76.83 ± 8.70 stems ha^{-1}. *Ficus* is the most diversified genera with 3 species follow by *Acacia*, *Combretum*, *Grewia* and *Piliostigma* with two. Among the trees recorded 2,846 stems (33%) were conserved in home gardens, 2,767(32%) in parklands whereas 3031 (35.06 %) were still in the natural savannahs. The natural savannah compared to the agrosystems is the most diversified. Similar results were obtained in parklands in Benin where 21 species belonging to 14 botanical families [9]. The number of species (33 species) found in Tandjile is low compared to the findings (293species) recorded in the Ngovayang's lowlands forests of Cameroon [19]. This number is also low compared to the result obtained in Ivory Cost [24]. The low density in the agrosystems is due to the selective cutting carried out by farmers (to aerate the crops, according to their environmental perception and their farm size).

Between the ethno-linguistic groups, the trend of the floristic diversity of the natural savannah is maintained except in Gama where the number of trees presented in home gardens is the highest. In the Guinean Savannah Highlands (GSH) of Cameroon, agroforests constitute one of the best niches where the farmer collection is conserved [11]. Various reasons can explain the situation in Tandjile-East: demographic explosion; the need to satisfy the demand for farmlands, slash and burn activities. In the area, farmers rely on fire woods. To protect useful tree species (food, medicines, etc.) traditional conservation strategies are developed by farmers as mentioned above.

The analysis of the family diversity in Tandjile east revealed that the most represented Fabaceae Mimosideae, Fabaceae Caesalpinoideae, Fabaceae Papillionideae, Combretaceae, Rubiaceae and Anacardiaceae. The Fabaceae Mimosoideae were represented by 4 genera with each 5 species whereas the Fabaceae Caesalpinoideae by 3 genera and 5 species (Fig.1). The families with two genera and 3 species followed them. It is the case of Combretaceae, followed by the families by Fabaceae Papillionoideae, Rubiaceae and Anacardiaceae with two genous and two

species each. The rest of families are represented by one genera and one species. Based on these results, it appears that the most diversified families in terms of genera are also in species. Similar trends are reported in the Bouba Bek and Nki national park [19, 25].

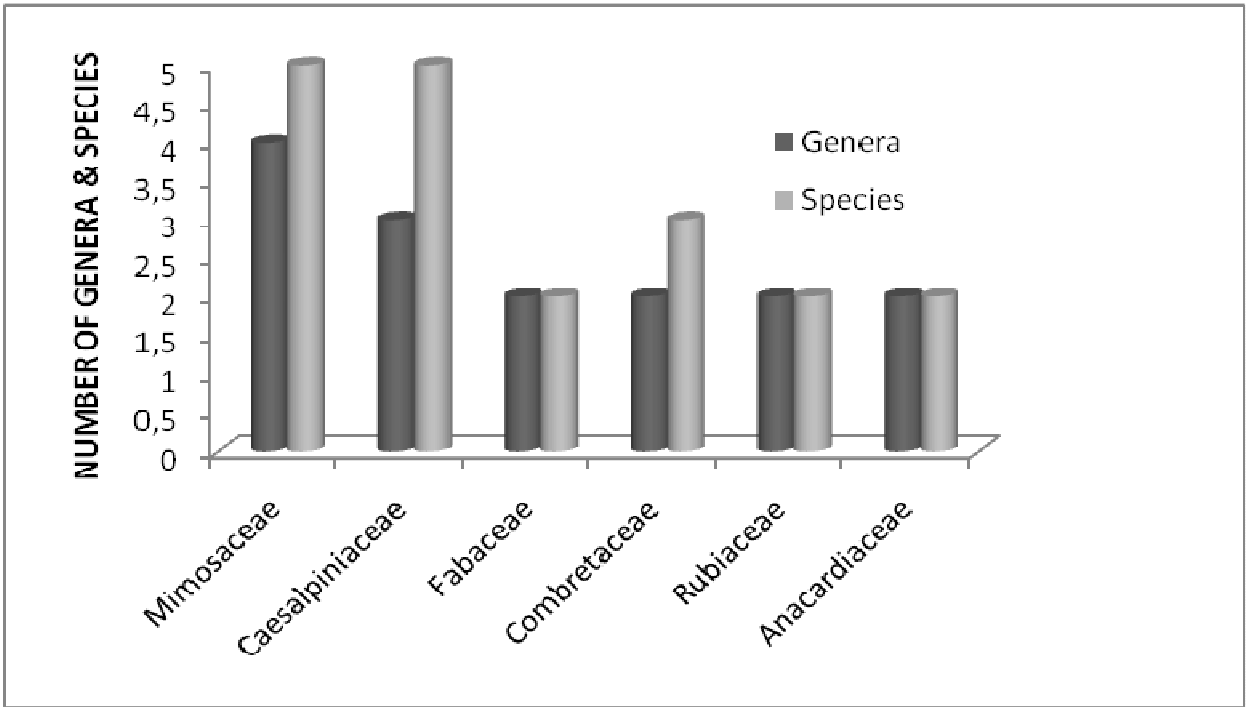

Figure 1. Family diversity showing number of genera and species in Tandjile.

For the most diversified genera, the following are concerned: *Ficus* (3 species), *Acacia*, *Combretum*, *Grewia* followed by *Piliostigma* with two species. The rest of genera is represented only by one species. Traditional agroforestry systems in Tandjile (Chad Republic) maintain a level of woody species richness which may contribute to biodiversity conservation at national, regional or even international level. This finding highlights the importance of local socio-economic and environmental factors on agroforestry systems diversity shown in parklands [9].

Table1. Diversity in Tandjile

Ethnies	Land use systems	Abondancy	Specific Richness	Shannon index	Simpson index
Gama	Home gardens	893	32	3.330	0.960
	Parklands	801	32	3.240	0.956
	Savannahs	794	30	3.250	0.958
Goulaye	Home gardens	982	31	3.304	0.960
	Parklands	1010	31	3.255	0.958
	Savannahs	1082	30	3.260	0.959
Gabri	Home gardens	981	31	3.339	0.963
	Parklands	992	31	3.275	0.959
	Savannahs	1148	30	3.226	0.956

In the present study, diversity was appreciated both by floristic list and diversity indices among which Shannon and Simpson. Forest communities considered rich are characterized by a Shannon diversity value of about 3.5 or higher [26]. However, the value of Shannon diversity index obtained in the present work are consistent with author who stated that the diversity produced by the only individuals of dbh more than 10 cm does not reflect all the diversity of a given area. The Shannon diversity index ranges from 3.226 in the savannah to 3.339 in home gardens whereas the Simpson varies from 0.956 (parklands for Gama, natural savannah in Gabri) to 0.963 in home gardens in Gabri ethno group (Table 1). Between the groups, the Shannon index is low in the Gama group and high in Gabri. In general, it appears that the lower the Shannon, the higher the diversity. Similar observations were reported in agroforests in the forest zone of Cameroon [27]. There is a similar trend between the Shannon and Simpson indexes, confirming the fact that the Simpson index is low in Gama and high in Gabri. This result demonstrates that biodiversity is conserved mostly in the Gama. The analysis of the abundance trends shows that the number of stems

in Gama (2488 stems) and Goulaye (3074 stems) groups is high than in Gabri. As shown by similar results in previous studies [28], such high diversity seems also to derive from a great abundance of particular species.

Dominant families and species

Considering the Family Index Value of the 17 families registered, two of them have a FIV which were more than 50 % (Fabaceae caesalpinoideae, 51%, Fabaceae mimosoideae, 62 %) (Fig.2). Analogous prevalence of the two families was reported in the forest zone of Cameroon [25]. Our results demonstrate the fitness of these families in Chad. The second group of families have theirs comprise between 10 and 50 %. This group is represented by Moraceae (24%), Anacardiaceae (21.90%), Rubiaceae (16%), Tiliaceae (13.7%), Sapotaceae (12.9%) and Apocynaceae (10.8%). The rest of FIV is under 10%. The importance of the Fabaceae Caesalpinoideae has been reported in Gabonese forest where 98 species were found [29]. In addition, the families' in order of importance is similar to the findings in the Dja forest in Cameroon [30]. Recently the prevalence of Anacardiaceae family was mentioned in Benin Parklands [9]. Based on FIV index, the most dominant families were Fabaceae Mimosoideae, Fabaceae Caesalpinoideae, Moraceae and Anacardiaceae. The importance of these families in Tanjile is seen not only in terms of species occurrence, but also in terms of tree density and basal area.

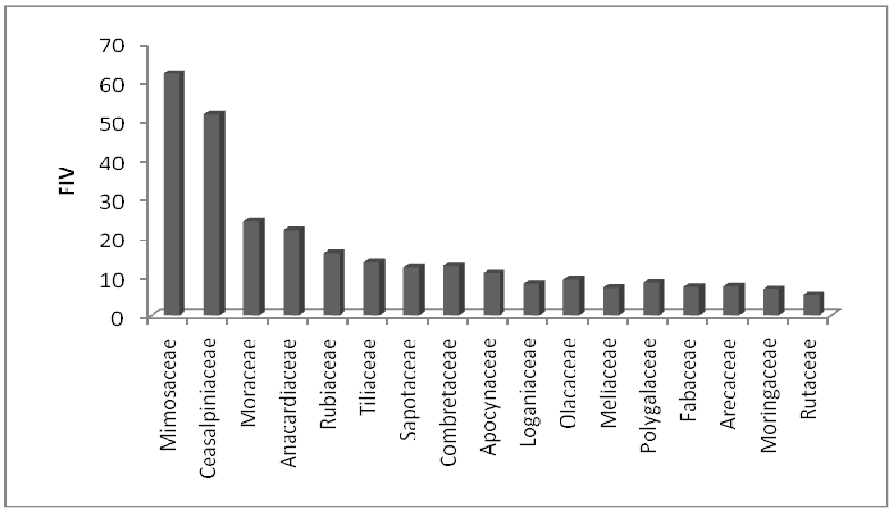

Figure 2.Ecological important families

Table 2.The Important Value Index (IVI) of top eighteen species of Tandjile. Relative Abundance (RA), Relative dominance (RD) and frequency (FR)

Species	RA (%)	RD (%)	FR (%)	IVI
Khaya senegalensis	3.25	5.40	100	110.27
Sclerocarya birrea	4.21	5.50	100	109.71
Vitellaria paradoxa	5.75	2.40	100	108.15
Piliostigma thonningii	4.64	3.50	100	108.14
Parkia biglobosa	5.55	2.30	100	107.78
Daniellia oliveri	3.26	8.20	95.55	107.02
Prosopis africana	4.04	1.70	100	105.74
Ximenia americana	4.27	1.30	100	105.57
Gardenia aqualla	4.56	0.74	100	105.30
Tamarindus indica	3.41	1.70	100	105.11
Detarium microcarpum	4.01	1.10	97.79	105.11
Grewia venusta	4.64	0.39	100	105.03
Strychnos spinosa	4.81	0.04	100	104.85
Securidaca longepedunculata	3.58	1.25	100	104.83
Landolphia heudelotii	3.49	3.30	97.78	104.57
Acacia albida	4.19	2.1	97.78	104.07
Afzelia africana	3.08	3.90	95.56	102.54
Lonchocarpus laxiflorus	3.30	0.58	97.78	101.66

However, the floristic composition of an ecosystem is not only based on the richness of the taxa in individuals. Many species which are less represented, can dominate in terms of number of stems. The Importance Value Index (IVI) of the 33 species listed in the east of Tandjile ranges from 17.24 in *Citrus lemon* to 110.27 for *Khaya senegalensis*. Beside it, the leading dominant species are 18 among which 12 are the most frequent (present in 100% of land use) (Table 2). The analysis of the IVI scores of species at the level of the zone showed that twelve of them

have an IVI which is more than 105. They are composed of *Khaya seneglensis* (110.27), *Sclerocarya birrea* (109.71), *Vitellaria paradoxa* (108.15), *Piliostigma thonningii* (108.14), *Parkia biglobosa* (107.78), *Daniellia oliveri* (107.02), *Prosopis africana* (105.74), *Ximenia americana* (105.57), *Gardenia aqualla* (105.30), *Tamarindus indica* (105.11), *Detarium microcarpum* (105.11) and *Grewia venusta* (105.03). The three leading species among which *Khaya senegalensis* (Meliaceae), *Sclerocarya birrea* (Anacardiaceae) and *Vitellaria paradoxa* (Sapotaceae) do not belong to the most important families confirming the result of the previous analysis.

In Benin, *V. paradoxa* and *P. biglobosa* were the most frequent species in parklands [9]. This result confirms the socio-economical importance of the two species for the farmers in arid zones. The most abundant species are composed by *V. paradoxa* (5.75%), *P. biglobosa* (5.55%), *S. spinosa* (4.81%), *P. thonningii* and *G. venusta* (4.64), *G. aqualla* (4.56%), *X. americana* (4.27%), *A. albida* (4.19%), *P. africana* (4.04%) and *D. microcarpum* (4.01%). Concerning the relative dominancy, *D. oliveri* (8.20%), *S.birrea* (5.50%) and *K. senegalensis* (5.40%) whereas for the frequency, twelve species are the most regular (100%) in all the list (*K. senegalensis*, *S. birrea*, *V. paradoxa*, *P. thonningii*, *P. biglobosa*, *P. africana*, *X. americana*, *G. aqualla*, *T.indica*, *G. venusta*, *S. spinosa* and *S. longepedunculata*). As in Benin, socio-economic and demographic factors such as household size and land holding size affected significantly species dominance in traditional land use systems. In addition, the number of trees per hectare was directly related to the size of the land holding and local perception of species abundance in the wild [9]. An important point relating to diversity creation is that farmers have many trees after the savannah clearance due to factors such as usability, growing location, and easiness to cut.

Use of the biodiversity by the local population

Although the majority of tree species integrated into the traditional agroforestry systems were multifunctional species, the reasons which support farmers' choice to protect them on their farmlands vary according to household view. The most important reasons were tree products contribution to food and medicine followed by commercialization of tree fruits, use of tree shade during farm activities and species contribution to soil fertility improvement such as *Acacia albida*. Concerning the income from tree species in traditional agroforestry systems, there is important variation according to the type of species. *Parkia biglobosa* appeared to have the higher number of marketable products followed by *Vitellaria paradoxa* and *Detarium microcarpum*, then *Lannea microcarpum.* This result confirms the fact that phytodiversity in traditional agroforestry is mostly dominated by tree species that are useful for the local population [31]. In Tandjile, a number of both native and exotic tree species occur in the traditional agroforestry systems with the dominance of indigenous tree species (85%). The implementation of these systems consists in maintaining useful seedlings or trees on farmlands when preparing a plot for cropping or the deliberate farmers' ambition to grow some useful species in the field. 16% of households surveyed were making deliberate efforts to plant some tree species on their farmlands. Both indigenous (*Vitellaria paradoxa, Parkia biglobosa, Khaya senegalensis* and exotic (*Mangifera indica*, Citrus spp.) species were planted by farmers. The main reasons which motivate them were species contribution to household nutrition (73%), its commercialization potential (26%) and its use as building materials (4%). On the other hand, the land tenure system was an important factor which determines farmers' choice to plant trees. The highest species diversity was observed with households that inherited land from their parents contrary to those obtained by simple donation. Similar descriptions have been reported in Bénin's parklands [9]. Farmers of the Tandjile east value these species for food, medicines and for biofuel. Similar observations have been reported by other works [9, 11, 32]. The mulitfonctionality of these tree species permitted to maintain them in farmlands during the time while their uses are modified along with the transformation of the society needs. The species which fall in to this category are composed of *Vitellaria pardoxa, Parkia biglobosa, Detarium microcarpum, etc.* (Table 3). Indigenous knowledge related to plant natural habitat, farmer symbolic charges and environmental perceptions are linked to the social and economic uses. In Gama, Gabri and Goulaye some of these endogenous knowledge are based on social ban which forbid cutting down important trees. Consequently in the communities, these species have the advantage to fall in traditional conservation status. In gama 'tribe, the Head of the village has reported that ''he who does not follow the social instruction of the community concerning the species of high conservation value, is expelled from and the decision is irrevocable''. Analogous facts were reported in agroforests of Sumatra in Indonesia [33]. In Benin, people's perception on the declining species abundance in the wild reported that the density of tree species in the traditional agroforestry parkland systems increase [9].

Table 3. List of multifunctional species managed by farmers in Tandjile East

Species	Families	Ethnies			Main uses
		Gabri	Goulaye	Gama	
Afzelia africana	Caesalpiniaceae	Tare	N'dileu	N'dila	Fodder, medicine
Acacia ataxacantha	Mimosaceae	Gariang	Ghare	Ghara	Fodder
Detarium microcarpum	Caesalpiniaceae	Gonglong	Mourkoutou	Koudou	Fruit, medicine, construction
Gardenia aqualla	Rubiaceae	Maourou	Mache	Madji	Fruit, medicine,handicraft
Tamarindus indica	Caesalpiniaceae	Ossi/Ossorou	Massou	Masse	Fruit, medicine
Vitellaria paradoxa	Sapotaceae	Theourou	Kiang	Songuo	Fruit, oil, medicine
Lonchocarpus laxiflorus	Fabaceae	Tourei	tirègne	Tirei	Medicine
Sclerocarya birrea	Anacardiaceae	Dilim/Dilimou	Galobe	N'Galobe	Fruits, medicine
Ximenia americana	Olacaceae	Bragnou	Jimkite	Titi	Fruit
Strychnos spinosa	Loganiaceae	Gougour	Douille	Douille	Fruit
Parkia biglobosa	Mimosaceae	Toulou	Mathe	Mathe	Fruit, spice
Prosopis africana	Mimosaceae				Fodder, Timber
Acacia albida	Mimosaceae	Kindebou	Dilou	Diri	N fixing tree, fodder
Daniellia oliveri	Caesalpiniaceae	Kara	Bite	Bida	Timber
Entada africana	Mimosaceae	Toulo-kindi	Kedaguen	Daguembian	Fodder
Combretum collinum	Combretaceae	Gabla	Rho-doule	Rho	Medicine
Securidaca longepedunculata	Polygalaceae	Dimegnou	Palia	Palé	Medicine
Sterospermum kunthianum	Bignoniaceae	Kulio	Barba	Barba	Fodder
Crossopteryx febrifuga	Rubiaceae	Begrai	Hedbigna	Signebigna	Medicine
Ficus gnaphalocarpa	Moraceae	Clah	Koté	Kobo	Fruit, fodder
Piliostigma thonnigii	Caesalpiniaceae	Goula	Monguo	Mongue	Fodder, fruit
Landolphia heudolotii	Apocynaceae	Oussoum	Komkague	Komkague	Fruit
Grewia venusta	Tiliaceae	Borou	Ghom	Ghum	Fruit
Moringa oleifera	Moringaceae	Kagbogo	Karbogo	Karbogo	Legume
Mangifera spp.	Anacardiaceae	/	/	/	Fruit, medicine
Citrus spp.	Rutaceae	/	/	/	Fruit, medicine
Psidium guajava	Myrtaceae	/	/	/	Fruit, medicine

Vegetation structure: diameter and height class distribution

Local people perception about species' abundance in the wild relies mainly on the facility they have to obtain species products. These various farmers' knowledges affect the population structure of the tree species in the farmlands, either in natural savannahs. The examination of the structure of four species of high conservation value showed different trends in the Tandjile region (Fig.3). In general, there are few young individuals in the following most important trees of the farmers: *Vitellaria paradoxa and Parkia biglobosa*, indicating a low regeneration of these species. Both the fruits and seeds of *Parkia biglobosa* are used for consumption and commercialization. The seeds are used in the manufacture of a local magi cube named ''Dadawa'' in fulani in Cameroon [34, 35] and ''sumbala'' in west Africa [36]. Analogous uses are reported in GSH of Cameroon [20]. Concerning *Viterllaria paradoxa*, the pulp of the fruits is consumed whereas the seeds are used in the production of butter which is very appreciated in the region. For the two species both the seeds and fruits as above, are collected and used in different traditional food industries. Harvesting all the seeds for these species does not give chance for them to germinate. However, there is no system of regeneration (natural or artificial) which can perpetuate the species. As it has been reported above that few farmers plant deliberately these trees. The common practice in the region is to protect important tree species for food, medicine, vegetable, species, construction, etc. during cleaning farms activities. Similar observations were done in the GSH of Cameroon [21].

Distribution of density by dbh-class showed a common tendency for individuals with smaller diameter to larger in number of individuals in general. It was classified that the distribution of diameter class showed a «L» shape pattern except in *V. paradoxa* and *P.biglobosa* indicating a possible regeneration of the population and the decline of adult stems. This observation is in line with the conclusion on the structure of population of most tropical forest trees [20, 21]. This trend explains their intensive exploitation by farmers to produce charcoal in the region. The diametric structures of *Acacia albida* shows a dominancy of young individuals, demonstrate the possibility of regeneration of the species in the region. The regeneration of this species is good due to its importance in improving soil fertility, fodders and uses in medicines. This result is contrary to observations in parklands of Northern Cameroon [37]. Nevertheless, for the four species, there is no seedling with dbh under 20 cm (Fig.3).

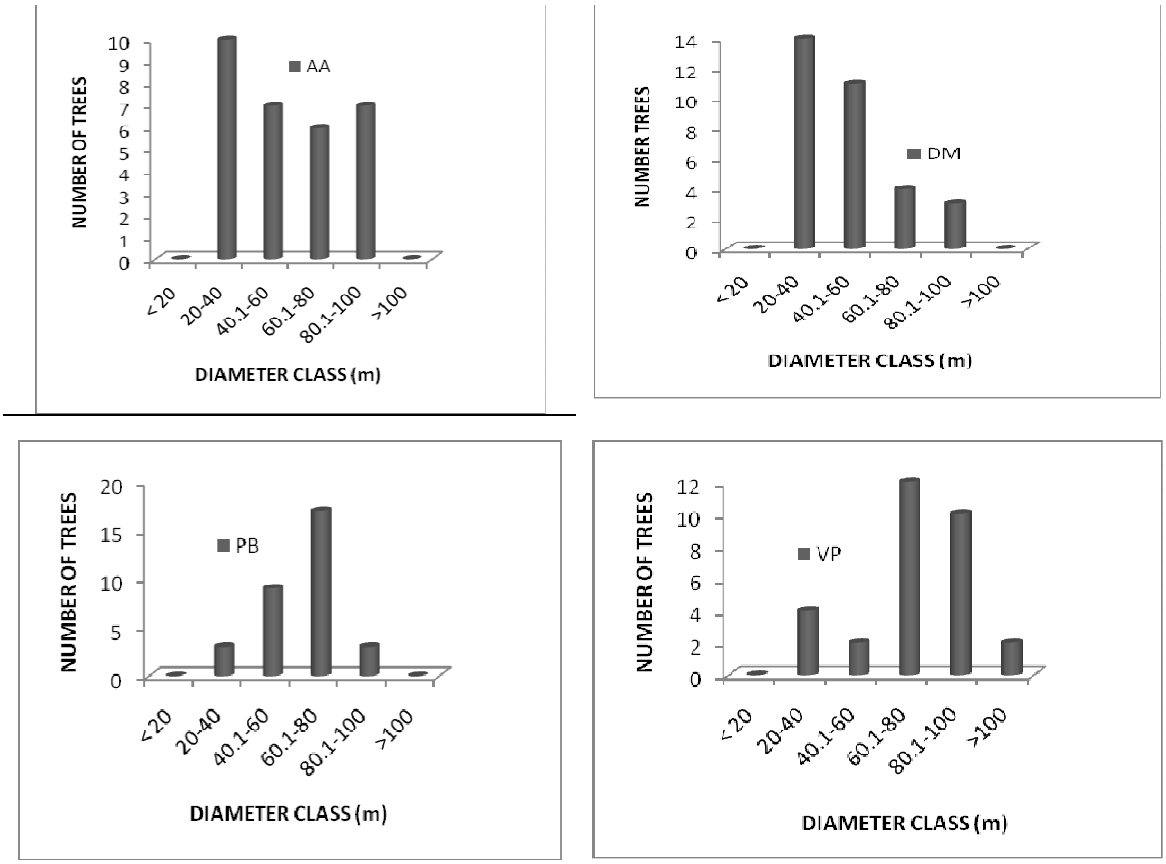

Figure 3.Diametric structure of some multifunctional species in Tandjile East: *Acacia albida* (AA); *Detarium microcarpum* (DM), *Vitellaria paradoxa* (VP) and *Parkia biglobosa* (PB)

For the vertical distribution, table 4 illustrates the vertical distribution of the most frequent multifunctional trees in various habitats. In general, trees are taller in the savannah (10.25m) than in agrosystems (8.67m). Similar results are reported in Cameroon on *P. Biglobosa* and other tree species [20, 21,38, 39]. Many reasons account for this anthropic pressure can affected the size of the tree. In agro-ecosystems, trees are managed by the farmers like other crops. To let light reaches the soil, farmers have to prune trees and by this way limiting competition between species, contrary to the natural savannah. Nevertheless, the ramification height of these trees is very low, less than 3 m. This is very important and suggests the fact that farmers can climb up in the tree to collect fruits without cutting down trees. The access in agrosystem lands is controlled by the owners whereas the natural savannahs are known as common lands and belong to all the members of the community. As it is, the land tenure is an important factor to be considered in the conservation and management of biodiversity and should be taken into account.

Tableau 4.Vertical distribution of tree species. Height of the live large branch (Hlb)

SPECIES	Home gardens		Parlands		Savannahs	
	Height (m)	Hlb (m)	Height (m)	Hlb (m)	Height (m)	Hlb (m)
Vitellaria paradoxa	10.15	2.62	11.5	2.83	12.25	2.15
Parkia biglobosa	11.5	2.41	12	2.8	12.6	2.2
Acacia albida	9.12	2.12	10.25	2.48	11.05	2
Detarium microcarpum	3.92	1.76	4,15	1.90	5.10	1.60
Mean	8.67	2.23	9.48	2.50	10.25	1.99
LSD .05	2.03	0.58	1.54	0.98	3.05	1.00

LSD = Least Significant Difference; Hlb = Height of the live large branchLSD = Least Significant Difference; Hlb = Height of the live large branch

The majority of home gardens and parklands are inherited from parents; others bought their lands from the village dignities whereas the other category is obtained by simple donation as a gift. The ownership in the land is loosed as soon as once left totally the village to another.

CONCLUSION

The number of species recorded in the present study was found to be more or less close to the number of species reported by others in the different ecosystems, using similar methodologies. The most important ecological families are represented by Fabaceae Ceasalpinoideae and Fabaceae Mimosoideae while the main ecological species are *Khaya seneglensis, Sclerocarya birrea, Vitellaria paradoxa, Piliostigma thonningii, Parkia biglobosa and Daniellia oliveri*. The most important diversified families are represented by Fabaceae mimosoideae, Fabaceae caesalpinioideae, Rubiaceae, Sapotaceae and Anacardiaceae which are known to be indicator of old evergreen forests by previous studies. *V. Paradoxa* and *P. biglobosa* are the most abundant and dominant tree species in theregion. The natural savannah is the most diversified niches (Natural savannahs > Home gardens > Parklands). Goulaye and Gabri contribute the most to biodiversity conservation in the area. This research highlights the role of traditional agroforestry practices to support tree species diversity and provides evidence of the farms' role as biodiversity reservoirs. The traditional institutions could play an important rule in the conservation of the plant diversity in Tandjile east. It also highlights the role of traditional agroforestry practices to support tree species richness and provides evidence of farms as biodiversity reservoirs which merit more research and development attention. Further studies characterizing plant and animal diversity, presence and distribution of species in the entire Chad are required to confirm these first conclusions, and thereby gain the data needed to support informed decisions on conservation and management of these environments.

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