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Full Length Research Paper

Prospects of agroforestry species in the woody communities of Northern Togo

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The surrender and no juridical statute areas of Northern Togo protected areas were subjected to forest inventory. The data obtained was analyzed after ethnobotanical investigation. The research was conducted in order to determine available forest agroforestry species. It is also aimed to assess and to determine their roles and functions; and to characterize the potential parkland of these areas. The 118 forest samples were processed floristically .Then, Ward method was used through the hierarchical clustering to cluster them into the main group. The agroforestry species sorted after ethnobotanic survey, were analyzed base on the information collected. The results showed that fifty plant species were recorded, among which twenty nine are agroforestry species. The Combretaceae and Leguminous are both the most frequent and the abundant families in the areas. The common agroforestry species still are *Vitellaria paradoxa, Parkia biglobosa, Lannea kerstingii, Vitex doniana, Ficus gnaphalocarpa, Sterculia setigera, Tamarindus indica* and *Adansonia digitata.* Four potential agroforestry parklands were found. Parks 2 and 3 present the aspect of regular parkland while the two others include some old fallows and shrubby savanna. The results of this study also show that apart from the frequently quoted agroforestry species, there are also many species which are important for the farmers.

Key words: Agroforestry, surrender, protected, areas, Togo.

INTRODUCTION

In Africa, particularly in Togo, the wooded ecosystems formerly protected by the endogenous techniques of resources conservation have been substituted by their classification into protected areas during the colonial period. During the post colonial period new protected areas were created, while the existing saw their boundaries extended (Tchamie, 1994; UICN, 1994). This period was characterized by a nonparticipative management with repressive policies. However, the decade of 90 years was marked by socio-economic disorders resulting into the invasion of the areas formerly protected (Ouro-Djeri et al., 2001). This has led to deforestation through land clearing and installation of fields. For 10 years and more, local populations have shaped the agricultural landscape around protected areas according to the endogenous technical of each community.

The consensual project of protected areas rehabilitation (UICN/PACO, 2008) launched in the year 2000 by the authorities, has allowed the demarcation of protected areas on the basis of conservation and protection of areas relatively quite diverse. Some parts disturbed by anthropogenic activities (fields, villages) have been surrendered to the local communities who are there. The reassigned parts present typologies of crops field, fallow and agroforestry park. In the Northern Togo agroforestry systems are an integral part of the agrarian landscape. These practices are endogenous, so that the area of protected areas occupied by local people has been subjected to these last. Certain protected areas of this region have taken the shape of mega parklands (Pereki et al., 2010). It is the traditional system of exploitation

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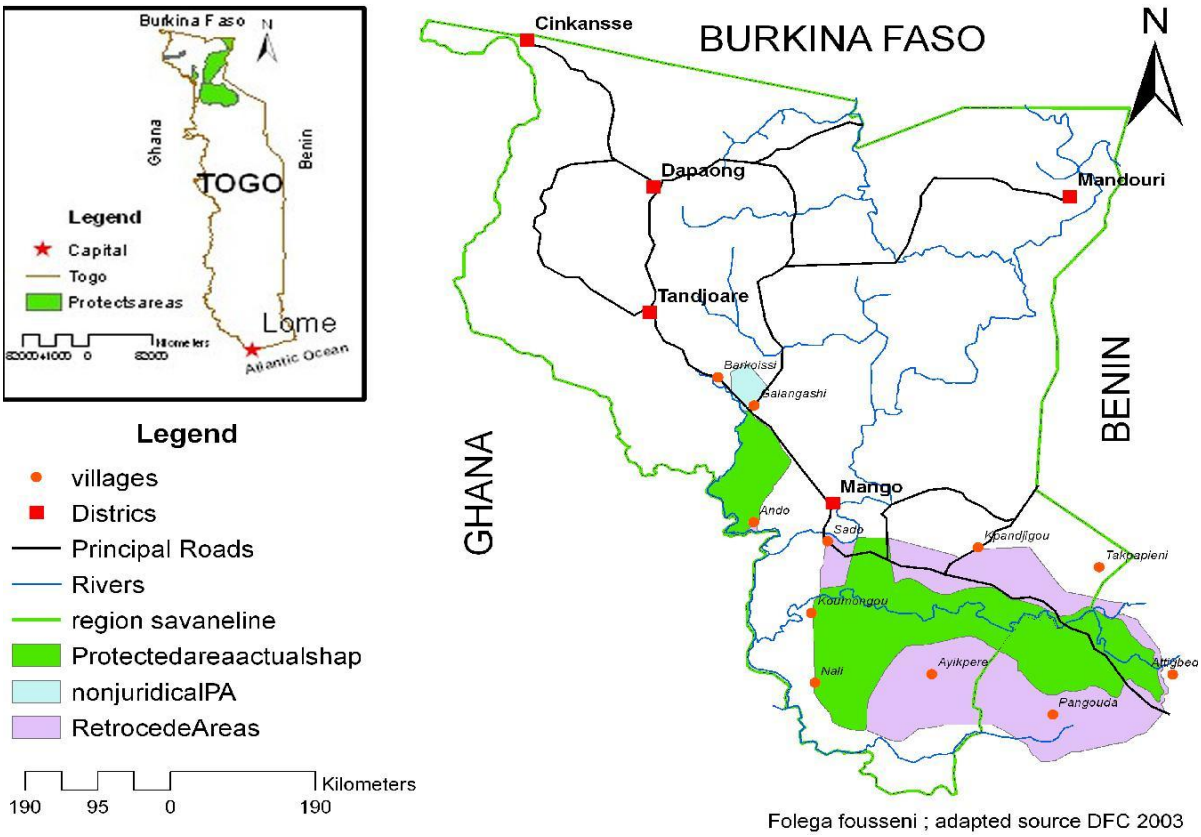


Figure 1. Study area.

(Kperkouma et al., 2005) of land occupied by local residents, in which perennial woody plants are deliberately preserved in association with crops and / or breeding in a dispersed space arrangement. This article attempts to contribute to the comprehension of biodiversity and tree resources available in the surrendered areas and no legal statute areas. The purpose is also to evaluate the potential of agroforestry species in the woody communities of these zones.

MATERIALS AND METHODS

Study area

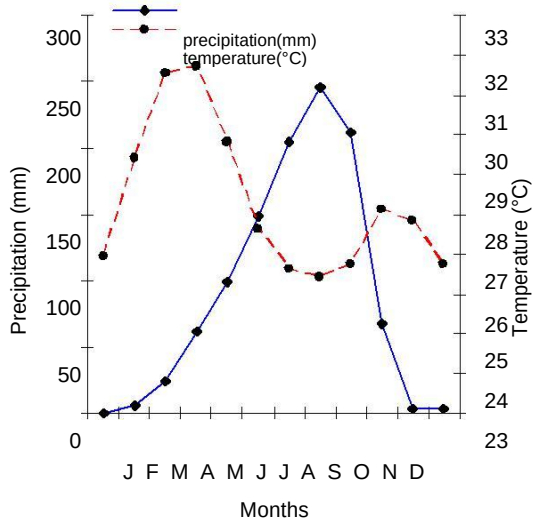
The study areas are located in Northern Togo, particularly in Region des Savanes. This administrative region is mainly included in Ecological field 1 (Ern, 1979) and is comprised between 11° and 10˚ of North latitude and between 0° and 1° of East Longitude (Figure 1). The study area is dominated by a vast plain which is bordered in the Southeast part by a mountainous chain considered as its natural limit. From a pedological point of view, the region is dominated by leached ferruginous soils covering a cuirass socle in the plain of Oti and hydromorphic black soil in the rare valley of the same plain. The hydrographic network of these protected areas is very dense. They are drained by two famous rivers, Oti and Koumongou.

The region has a Sudanese tropical climate marked by the alternation of a long dry season and short rain season (Yema et al., 1981). Temperatures vary between 20 and 35°C with an annual average of 28.5°C for the Mango meteorological station (Moussa, 2008) (Figure 2). The major human activities are agriculture, hunting, firewood collection and the initiation of bush fires during the dry season. The main crops species are sorghum, millet, groundnuts, cowpeas, maize and yams. Livestock include poultries, caprine and sheep. The many ethnic group living around the protected areas include Moba, Tchokossi, Yanga and Fulani.

The investigations areas are situated respectively in Barkoissi, Galangashi and Oti-Keran protected areas and concerned the surrender area and areas with none juridical statute. During the 90s, the three protected areas, whose gazettation took place 30 years ago, were subjected to illegal occupation and other disturbance activities from the local population. In order to conserve the essential part of these ecosystems, the project of consensual rehabilitation of protected areas has redesigned their boundaries and surrendered the zones which are more disturbed by anthropogenic activities to local communities.

Data collection

Primarily, a pure floristic and phytosociological data collection was done through the retrocede areas, none juridical statute areas include the most disturbed zone of the three protected areas. The technique of sampling adopted is based on the Braun-Blanquet (Westhoff and van der Maarel, 1978) phytosociological concepts. The samples of 30×30 m (900 m^2) spaced at least by 100 m, are randomly placed. For a given sample, all the species found, with a DBH ≥10 cm were recorded and named using the nomenclature of



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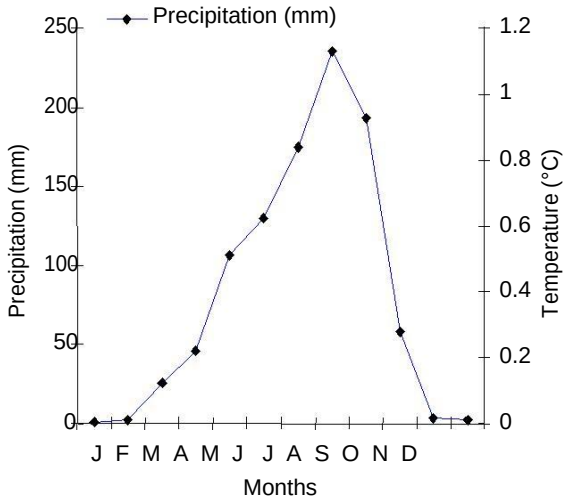

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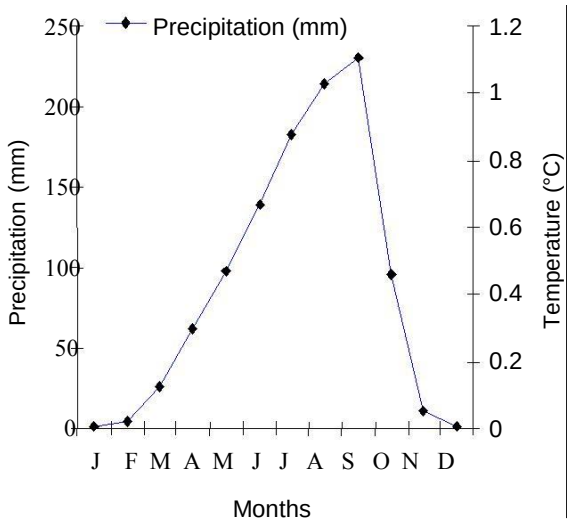

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Figure 2. Climographs of the main meteorological station.

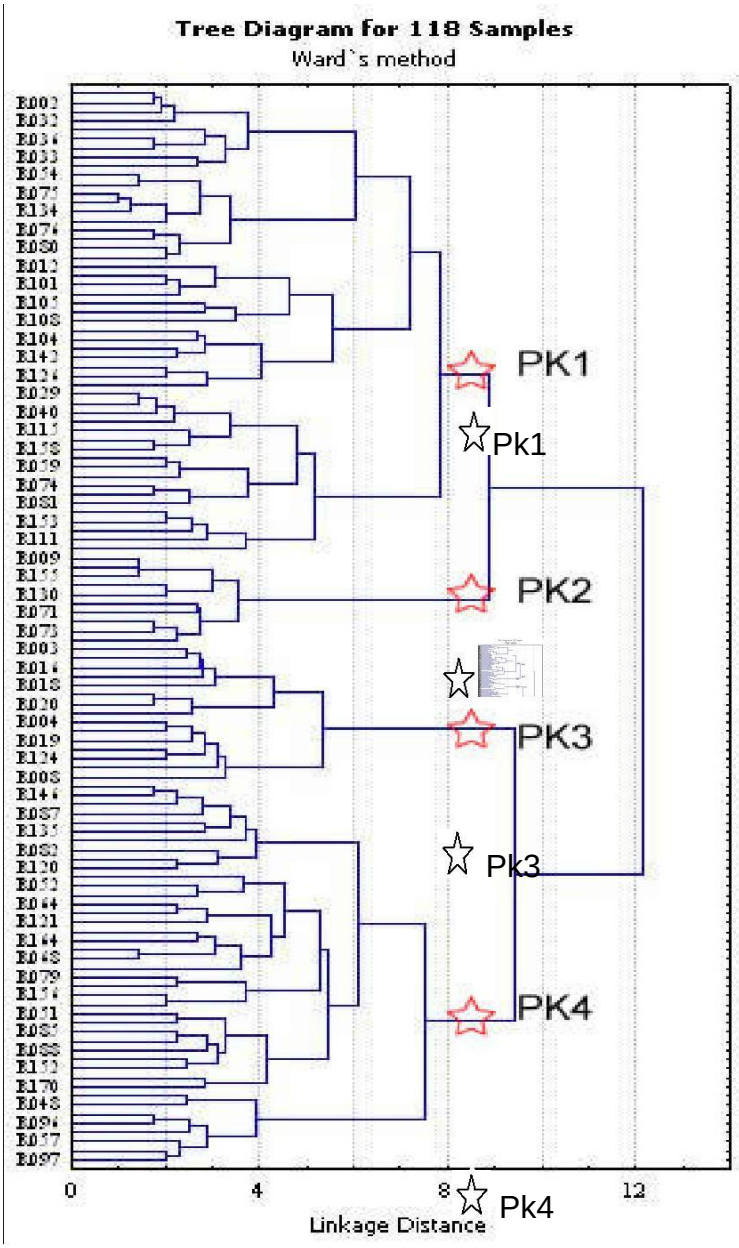

Figure 3. Dendrogram showing the four potential agroforestry parklands.

Hutchinson and Dalziel (1958, 1963, 1968, 1972).

For each species, the number of individuals was also recorded. For qualitative ecological characterization, edaphic variables (structure and texture of the soil), topographic attributes (plateau, slope, versant, valley and bank) and disturbance levels (fire, cutting, pasture, hunting and transhumance) were recorded along with the geographic coordinates. Climatological data (rainfall, temperature and humidity) for any period were obtained from databases of meteorological stations of Mango, Barkoissi and Takpamba.

Data processing and analysis

Among the 125 samples established in the three protected areas, 118 consisting of shrubby savanna, tree savannas and potential fallows were sorted. In these 118 plots, all of the disturbances mentioned earlier are found. In most of the case they presented fallow characteristics. After digital processing of the 118 plots, the general list of plants species was established. From this list, all potential and common agroforestry species were sorted. From this specific list of species, an ethno botanical investigation was carried out, in order to determine their vernacular names, their main functions and uses.

To determine the clusters with parkland characteristics, the 118 samples were subjected to the hierarchical classification (Figure 3) by the method of Ward (1963), using the Euclidean distance. The agroforestry species abounded in a given cluster was used for its characterization. For each cluster, indices of diversity; species richness, Shannon index (Shannon, 1948), Pielou's evenness

Table 1. List of important agroforestry species.

Scientific names	Vernaculars names	Uses and functions
Adansonia digitata L.	Toukala (Mb), Chiragna(Tk)	Fd Am Ec
Annona glauca Schum. and Thonn.	i	Am
Anogeissus leiocarpus (DC.)Guill. and Perr.	Piega (Yg)	Md Sw Ec
Azadirachta indica A.Juss.	Pangouda (Mb)	Md Fw Am
Bombax costatum Pellegr. and Vuill.	Faule (Mb), Sangboko (Tk), Voaga (Yg)	Fd Bd Ec
Combretum glutinosum Perr. ex DC.	i	Fw
Combretum micranthum G.Don.	Kang (Yg)	Md Fw Am
Daniellia oliveri (Rolfe) Hutch. and Dalziel	Honga (Yg)	Sw
Detarium microcarpum Harms	Koukei (Pl)	Md
Diospyros mespiliformis Hochst. ex A.DC.	Ga (Mb)	Fd Fw Am Ec
Ficus sycomorus Linn. subsp. Gnaphal	Kinkanan (Mb)	Bd Fw
Ficus vallis-choudae Delile	Kinkang loung (Mb)	Bd
Gardenia erubescens Stapf and Hutch.	Nassabla (Mb, Yg)	Fd Md Ec
Lannea kerstingii Engl. and K.Krause	Sinsabdjak (Mb)	Fd Ec
Lannea microcarpa Engl. and K.Krause	Sinsabi (Mb)	Fd Ec
Mitragyna inermis (Willd.)O.Kuntze	Gilg (Yg)	Am
Nauclea latifolia Smith	Gwongue (Mb)	Md
Parkia biglobosa (Jacq.)R.Br. ex G.Don f.	Doug (Mb)	Fd Am Ec
Piliostigma thonningii (Schumach.)	Naban (Mb)	Bd
Prosopis africana (Guill. and Perr.)Taub.	Duanduangha (Yg), Kohy (Pl)	Sw
Pterocarpus erinaceus Poir	Kpesna (Mb)	Bd Sw
Sclerocarya birrea (A.Rich.)Hochst.)	Nagnâ (Mb)	Fd Bd Fw Sw Ec
Sterculia setigera Del.	Boufobou (Yg)	Sw
Strychnos spinosa Lam.	Kampoade (Mb, Yg)	Fd
Tamarindus indica L.	Pouska (Yg), Poug (Mb)	Fd Md Ec
Terminalia macroptera Guill. and Perr.	i	Am
Vitellaria paradoxa C.F.Gaertn.	Sana (Mb), Tama (Yg)	Fd Md Am Ec
Vitex doniana Sweet	Ngana (Mb)	Fd Ec
Ziziphus mucronata Willd.	magunuga (Yg)	Fd Md

Local ethnic group (Mb: Moba, Pl: Peuhl or Fulani, Tk: Tchokossi, Yg: Yanga, i: undetermined). Uses and functions:(Bd: breeding, Fd: food, Ec: economic, Md: Medicine, Sw: service wood, Fw: fire wood, Am: amendment).

(Pielou, 1975) were computed without forgetting the basal area (G). The following formula was used to calculate these indices:

Shannon diversity index (H'):

$$H' = -\sum_{I=1}^{S} (NI / N) \cdot \log_2 (NI / N)$$

Pielou's evenness index (E):

$$E = \frac{H'}{H' \max} = -\frac{\sum_{I=1}^{S} (NI / N) \cdot \log_2 (NI / N)}{\log_2 (S)}$$

Where *Ni* is the number of relevés in which the species *i* is present; *N* is total number of relevés and *S* is the number of species.

- Basal area (G): $G = \sum \pi \frac{D^2}{4}$

Where *G* is the basal area (m²/ha), D the diameter (m) at 1.3 m of the ground. The data processing and analysis were done using Statistica 7.0.

RESULTS

From the floristic processing, 50 forest species are listed among which 29 (58%) are represented by the agroforestry species (Table 1). *Combretum glutinosum* (14.56%), Terminalia *macroptera (*13.14%), *Detarium microcarpum* (10.59%), *Vitellaria paradoxa* (10.35%), *Pterocarpus erinaceus* (8.74%), *Terminalia laxiflora* (7.75%), *Piliostigma thonningii* (7.42%), *Pteleopsis suberosa* (4.91%), *Daniellia oliveri* (3.45%) and *Anogeissus leiocarpus* (3.35%) constitute the ten most abundant agroforestry species in the area. *V. paradoxa, Parkia biglobosa, Lannea kerstingii, Vitex doniana, Ficus gnaphalocarpa, Sterculia setigera, Tamarindus indica* and *Adansonia digitata* are the frequent species in the fields and in young fallows. Four agroforestry parks can be identified from the 118 samples based on their floristic composition (Table 2).

The first is dominated by *V. paradoxa, F. gnaphalocarpa*,

Table 2. Table showing diversities indices inside each group.

	S	S'	H'	E	G
Park 1	47	28	4,53±0.0129	0,82±0.0023	30.89 ±0.0018
Park 2	18	10	3,18±0.0160	0,77±0.0039	1.60 ±0.0007
Park 3	30	20	3,36±0.0153	0,69±0.0031	5.04±0.0005
Park 4	45	27	4,66±0.0125	0,85±0.0022	18.18±0.0011

S: Species richness, S': number of potential agroforestry species, H': index of Shannon (bits), E: evenness of Pielou, G: basal area (m^2/ha).

P. thonningii and *C. glutinosum.* However the species endemic to the dry forests such as *P. erinaceus, A. leiocarpus,* and *D. oliveri* are well represented*;* 47 forest species are recorded, among which 59.57% are agroforestry species. The Shannon and Pielou diversity indices are respectively, equal to 4.53 bits and 0.82. The basal area occupied by the species of this park is 30.89 $m^2.ha^{-1}$. The second has 18 forest species among which 10 are considered as agroforestry. *V. paradoxa, Gardenia erubescens, Sclerocarya birrea,* and *V. doniana* are abundant but associated to strong presence of Combretaceae such as *Combretum micranthum* and *C. glutinosum.* The indices of diversity and basal area are respectively equal to 3.18 bits, 0.77 and 1.60 $m^2.ha^{-1}$.

The third is dominated by *V. paradoxa, D. microcarpum, S. birrea* and *Lannea microcarpa*. However, there is a significant presence of the following species: *P. thonningii, Strychnos spinosa, Prosopis africana* and *Annona glauca*. The 30 species recorded for this group include 66.66% of agroforestry species. 3.36 bits and 0.69, represent the index of Shannon and Pielou's evenness respectively. Its basal area is 5.04 $m^2.ha^{-1}$. *S. birrea, V. paradoxa, P. erinaceus* associated with *C. micranthum* and *P. thonningii* abound in group four. This group consists of 45 species including, 27 agroforestry species. 4.46 bits and 0.85 correspond to Shannon index and regularity of Pielou, whereas the basal area is equal to 18.18 $m^2.ha^{-1}$.

DISCUSSION

At the end of this exploratory study, fifty woody tree species have been identified. This low proportion of woody species is undoubtedly related to the nature of the area and the sampling criteria (Folega et al., 2010), according to which only the species having a DBH ≥ 10 were taken into account. The 29 species identified as agroforestry also appear on West Africa agroforestry species list (Jean, 1994). Among these species, *A. digitata, A. leiocarpus, Bombax costatum, P. biglobosa, P. africana, P. erinaceus, T. indica, V. doniana and V. paradoxa* enjoy special protection in Burkina Faso (ONAPAD, 2005) showing the function of these taxa in these dry ecosystems. The predominance of Combretaceae and leguminous plants would be related to the sudanian tropical climate (Folega et al., 2010), which prevails in this part of Togo.

However, the frequency of species such as *V. paradoxa, P. biglobosa, L. kerstingii, V. doniana, F. gnaphalocarpa, S. setigera, T. indica* and *A. digitata* is the result of preservation of these species in agricultural landscapes. That explains their presence in fallow as well as in croplands. The interest in these species may also be due to the fact that they are part of the minor food crops, spontaneous or wild in Regions des Savanes (Togo) (MAEP, 2007). The investigation results provide evidence of how agroforestry species are important to the diet and economy of local people who live in this region (Table 1). This is consistent with the floristic results aforementioned where *V. paradoxa, P. biglobosa, T. indica* and *A. digitata* are part of the species benefiting conservatories measures among farmers.

However, the resources of other species are also involved in promoting the local economy, hence the need to promote these last in order to revitalize and diversify resources in agroforestry parks (Pereki et al., 2010). The potential parks determined after the cluster analysis show a significant difference between these groups. Park 1 is similar to the Park 4 (Table 2).The high indices of diversity, they present are strongly linked to their old fallow state; characterized by the resurgence of pioneer and spontaneous species. It is also important to take into account the shrubby savanna character of certain samples forming these clusters.

The two other clusters consist of few samples (Park 2 = 10 samples; Park 3 = 15 samples) compared to Parks 1and 4 which have 41 samples each. However, 56% of samples of Parks 2 and 3 are located in Barkoissi protected area, which presents nowadays a parkland aspect. The weakness of diversity indices in these clusters would be due to the thorough selection carried out by the peasants on the species present during the agro-pastoral practices.

Conclusion

The knowledge of the preferred species by peasants will obviously help to direct the possible work of domestication of the woody species in the zone. This

research shows that apart the frequent quoted agroforestry species; there are also many species which are of great important for the peasants. It confirms the fact that, it is the biodiversity of the parks taken in their sets, and not only their density, which must be protected, within a total framework of installation including the sustainable management of the phytogenetic resources.

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