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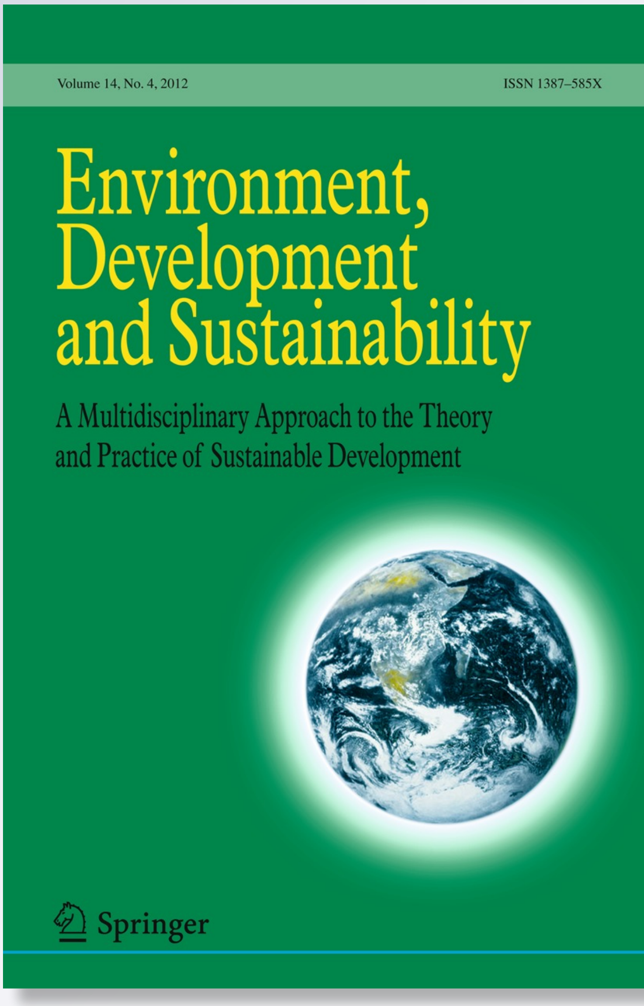

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Ethnobotanical knowledge and valuation of woody plants species: a comparative analysis of three ethnic groups from the sub-Sahel of Burkina Faso

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Abstract Local people's perceptions of plant species are an important source of information on species distribution and rarity, as well as long-term vegetation change. This study involves an ethnobotanical survey and the identification of potential factors that explain differences in the perceptions and valuation of woody plant species in three ethnic groups (Fulani, Mossi and Samo) of the sub-Sahel of Burkina Faso. Some 87 groups of informants from 20 villages were interviewed for this study. A species list of woody plants and their estimated abundance was categorized in terms of their uses: food, medicine, fodder, construction, energy and handicrafts. In addition, the most important species, and those considered a priority for conservation, were identified. A total of 90 woody species were mentioned in the six categories. They were from 64 genera and 32 families and subfamilies, of which the Caesalpinioideae, Combretaceae, Mimosoideae and the Capparaceae dominated. In all three ethnic groups, more than 80 % of the reported species were used for energy, 60 % for medicine and 40–50 % for food. Gender was not a determinant of plant use. However, age was found to have an impact on plant knowledge in all three ethnic groups, with older people (over 50 years) reporting significantly more species than younger people (25–50 years): ($U = 425$, *df*: 15, 14, $z = -4.42$, $p < 0.05$). There was a significant difference in plant use among the three ethnic groups (ANOSIM; $R = 0.64$, $p < 0.001$), and this could be explained by differences in culture and local environmental conditions controlling species distribution and availability. *Balanites aegyptiaca* was the most used species by all three ethnic groups. The most important species and identified conservation priorities, from the informants' perspective, were similar for all ethnic groups and were mainly food species with a high socioeconomic value: *Vitellaria paradoxa, Adansonia*

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digitata, Tamarindus indica, Parkia biglobosa, Lannea microcarpa and *Ziziphus mauritiana*. Development projects should incorporate the preferences of local people for certain species as part of the overall strategy for poverty alleviation in Burkina Faso.

Keywords Ethnobotanical knowledge · Ethnic groups · Woody plant species · Use category · Most important species · ANOSIM · Conservation priority · Sub-Sahel · Burkina Faso

1 Introduction

The Convention for Biological Diversity (CBD 1994) firmly acknowledges the role of indigenous knowledge in biodiversity conservation. In particular, ethnobotanical knowledge has received much attention in resource management, pointing to new paths in scientific research, conservation monitoring and development of understanding of ecological processes. In this way, the incorporation into biological and ecological studies of local use patterns and of the social and institutional background that guides the connection between people and nature, has led to a greater understanding of the relationship between social and ecological dynamics (Ghimire et al. 2005). Moreover, understanding local knowledge of native plant species can guide the identification of research priorities for better, sustainable management of natural resources (Ayantunde et al. 2008).

In the West African Sahel, local vegetation plays a pivotal role in the everyday lives of rural populations, providing livestock with fodder and people with food, fuel and medicine, as well as materials for construction and the manufacturing of crafts and many other products (Ayantunde et al. 2008; Sop et al. 2011). A large variety of natural plants are used for multiple purposes (von Maydell 1990), and consequently, vegetation changes in the Sahel can have significant impacts on the rural economy. Species losses or declines affect the quality of life of local people, including their health, nutrition and household income.

Ethnobotanical knowledge has been shown to be a relatively accessible and reliable source of information on vegetation dynamics. It can also provide valuable information about single species, which can be directly applied to local resource management (Wezel and Lykke 2006). The perceptions of plant species by local people complement data from vegetation studies, which are less able to provide insights into long-term vegetation change and the distribution of rare species (Lykke et al. 1999). Moreover, many native woody species have important potential for agroforestry and the restoration of degraded lands. Thus, knowing the preferences of local people helps to implement management solutions for natural resources that are locally accepted and better match their needs (Belem et al. 2007).

Plant knowledge and perceptions of local populations in Burkina Faso have been increasingly investigated and used to understand species dynamics and the extent of vegetation change during the last decades (von Maydell 1990; Hahn-Hadjali and Thiombiano 2001; Wezel and Haigis 2000; Müller and Wittig 2002; Kristensen and Balslev 2003; Taita 2003; Lykke et al. 2004; Wezel and Lykke 2006). However, only a few of these studies focused on the communities of the Sahel, and most did not explicitly address the variability to be found in local knowledge of plants among ethnic groups within the same phytogeographical zone. Exploring this aspect could greatly advance the understanding of species' niches, present and past distributions, extent of use and types of threats. It can help identify key woody plant resources and enhance conservation measures at a larger scale and across ethnic boundaries.

A number of quantitative methods using different indices have been developed to investigate the cultural importance of plant species to different populations and social groups (for a review, see Hoffman and Gallaher 2007). Quantification of plant use and local knowledge serves to make useful comparisons between different groups of informants (Kristensen and Balslev 2003). This study employed the use-value index (Phillips and Gentry 1993) to assess the relative importance of woody species to various ethnic communities.

The valuation of plant resources is dependent on factors such as ethnicity, gender, age, education, social and economic status, roles and responsibilities in the home and community, profession, aptitude and intellectual ability, and control of natural resources (Holt 2005; Ayantunde et al. 2008). For this reason, it is assumed in this study that the use patterns of woody plant species may differ between the ethnic groups of the sub-Sahel. The identification of the groups of plants that are most important to local people will help to identify priorities for conservation and to implement sustainable management strategies (Camou-Guerrero et al. 2008).

Considering three ethnic communities across the sub-Sahel of Burkina Faso, the objectives of this study were threefold: (1) to realize an ethnobotanical survey of all woody plants species; (2) to investigate intra- and inter-cultural variation in plant knowledge by assessing the impact of age, gender and ethnicity on the use and perceived value of woody plants; and (3) to assess the most important, and preferred, species for conservation. It is hypothesized that the knowledge of plants is similar within ethnic groups whereas it differs among them. The results of this study will form the basis for implementing sustainable management and conservation strategies that incorporate local species preferences in the definition of policies for poverty alleviation.

2 Materials and methods

2.1 Study area

This study was conducted in October and November in both the years 2008 and 2009 in the sub-Sahelian phytogeographical sector (Fontes and Guinko 1995) of Burkina Faso. The study area is situated between approximately 13°N and 14°N and stretches from the west to east of the country (Fig. 1).

The climate is tropical with two distinct seasons: a rainfall season between June and September, and a dry period between October and May. Mean annual rainfall has ranged from 500 to 650 mm over the last 30 years. There is a slight rainfall gradient from the east (500 mm) to the west (646 mm) of the study area.

Vegetation comprises a mixture of woody and herbaceous species from the Sudanian, Sahelian and Saharan floristic elements. Natural vegetation is sparse and ranges from grassy/shrubby steppes to shrubby/woody savannas with characteristic, impenetrable bushes called “brousses tigrées” (tiger bush) (Guinko 1984; Sop et al. 2011). In these savannas, woody species consist mostly of shrubs and trees from the Fabaceae–Mimosoideae, while herbaceous species are mainly Poaceae. Remnants of riparian forests are found along the ephemeral rivers that flow through the sub-Sahel during the rainy period. The dominant land use type is agroforestry parkland, a much modified habitat that reflects the full extent of the human footprint in the region. The main livelihoods of local people are livestock breeding and traditional subsistence agriculture of mainly cereals (maize, sorghum and millet) (Fig. 1).

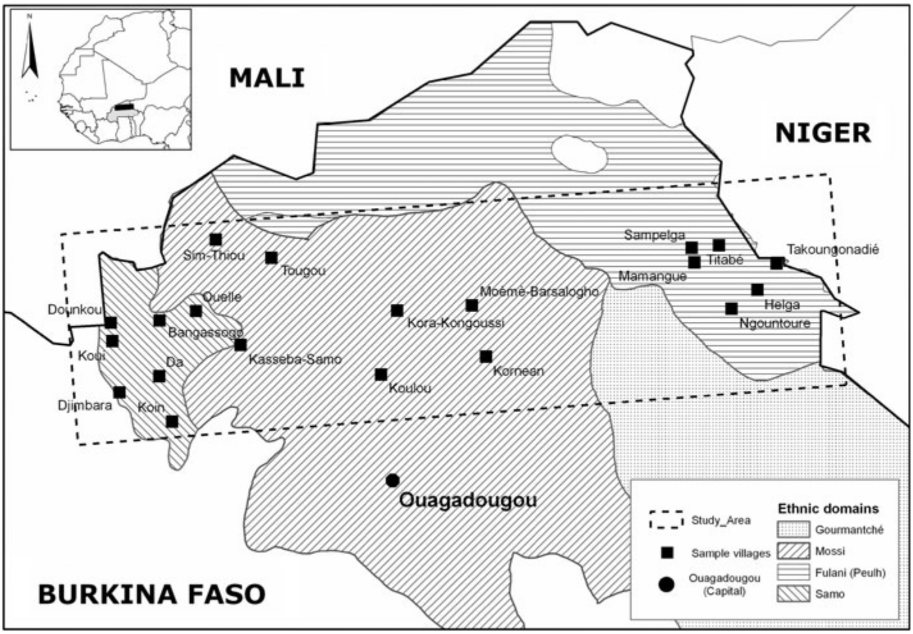

Fig. 1 The study area in the sub-Sahel region of Burkina Faso containing 20 villages across three main ethnic divisions. The Fulani ethnic group is located in the east and north of the country, the Mossi in the center and the Samo in the west. The Gourmantché ethnic group was not included in this study

2.2 Ethnic groups and cultural settings

Four ethnic groups live within the study area: the Fulani, Mossi, Samo and Gourmantché. The latter was not included in this study because there were too few Gourmantché residents in the area.

Representing more than half the total population of the country, the Mossi tribe is the dominant ethnic group in Burkina Faso. Its homelands extend across the central plateau, and traditionally, its rural economy is dominated by subsistence agriculture (millet, sorghum, maize and cowpea). In recent times, many Mossi households are also engaged in animal husbandry (cattle, sheep and goats). Religious beliefs include Christianity, Islam and traditional African religions.

The Fulani account for a tenth of the total population of Burkina Faso and are historically nomadic livestock breeders and pastoralists (goats, sheep, cows and donkeys). Over time, they have become increasingly involved in subsistence agriculture (cereals), moving into a seminomadic or even a sedentary way of life.

The Samo make up only 2 % of the country's population and inhabit the western region of the country. The Samo are a farming people; however, households are increasingly combining the traditional subsistence farming system with small-scale animal husbandry (sheep, goats and pigs). One of the characteristic features of a Samo village is the presence of wooden enclosures for gardening beside each compound. They are mostly Christians and Animists.

2.3 Ethnobotanical survey

Twenty villages were included in the survey, from which 87 groups of informants were interviewed (59 groups of men and 28 groups of women). Six Fulani, seven Mossi and seven Samo villages were included in the study (Table 1). At each village, three to five groups of informants, each of 3–15 people, were questioned using semi-structured interviews. Age, gender, occupation and ethnic group of the informants were recorded. In this paper, the terms "group of informants," "informants" and "respondents" are used interchangeably. The aims and objectives of the study were explained to the local traditional authorities beforehand, to obtain consent for the research. It was not possible to interview equal numbers of men and women due to the traditional rules that govern many societies in the Sahel. In some cases, women refused to be interviewed without the consent of their husbands, and in other cases, husbands believed that women were not sufficiently knowledgeable about plant resources to be interviewed. It might useful to mention that the main author that conducted the interviews as well as the interpreters were males. Respondents to the questionnaires were all over 25 years old. The reason is that young people lack experience and this probably limits their perceptions of vegetation change over time. Each interview lasted between 1 and 2 h. Interviews were conducted, between October and November in both 2008 and 2009, by the first author and, with the assistance of interpreters, in the informant's native languages (Fufuldé, Mooré or San). Each group of respondents was asked, as fully as possible, to:

- list woody species used for food, medicine, fodder, construction, energy and handicrafts, and estimate their abundances according to the scale: 0 (locally extinct); 1 (rare); 2 (a few of); 3 (moderate); 4 (common);
- identify the five most important species and rank them in decreasing order of importance;
- identify five species they felt should be given conservation priority (again ranked in decreasing order of importance).

The interviews were facilitated by the first author to ensure that all the members of a group could equally express their opinion. This was to reduce a bias toward the views of more vocal participants, as is common in group situations (Pilgrim 2006). In a few rare cases, voting was used to reach agreement on ranking and prioritization. At the end of each interview, a guided tour of the village surroundings was usually undertaken to observe and collect specimens of some species mentioned by the informants.

Table 1 Sampling parameters and study design

Ethnic Group	No. of villages	Gender	No. of groups of informants	Mean no. of people per group	Age range
Fulani	6	F	9	4	42–60
		M	17	4	34–67
Mossi	7	F	11	6	27–60
		M	18	8	25–85
Samo	7	F	10	4	35–73
		M	22	4	29–80
All	20	F	30	5	27–73
		M	57	4	25–85

Voucher specimens of all the plants listed by the informants were collected and identified. Nomenclature followed Arbonnier (2004) and Lebrun et al. (1991). Identification of specimens was validated in the herbarium of the University of Ouagadougou (OUA). The Latin names of plants were updated using the International Plant Names Index database (IPNI 2011).

2.4 Data analysis

The answers from the 87 groups of informants were converted into the following matrices: (a) informants × species use category; (b) informants × species abundance; and (c) informants × species importance/conservation priority. The data were either dichotomized to the value 1 or 0 (signifying whether a respondent mentioned an item or not), or else put in the rank order in which an item was mentioned by the informants.

Assessment of the local knowledge of each ethnic group followed the cultural consensus model (Friedman et al. 1986) in which the degree of agreement among informants from the same ethnicity is calculated. The ethnobotanical knowledge of each ethnic group, village, gender and age class for a particular use category was calculated as the total number of reports mentioned by each group of informants for that category.

2.4.1 Relative importance of woody species based on use value

The relative importance of each plant was quantified by calculating the use value (UV) of each cited species, following Philips et al. (1994):

$$\mathrm{UV} = \sum U_i/n,$$

where U_i is the number of use categories reported by each group of informants for a given species and n is the total number of groups of informants. Use value was computed for all plants recorded in each ethnic group and across all ethnic groups. The use-value index is perceived as objective and reproducible and allows hypothesis testing (Hoffman and Gallaher 2007, Ayantunde et al. 2009). One of the common criticisms of the use-value method is that it does not differentiate between plants that are used for only one purpose and those that serve multiple purposes in a category. Nevertheless, the use value of a species reflects its importance to the informants and is therefore seen as an appropriate method for statistical analysis (Phillips and Gentry 1993; Philips et al. 1994; Ayantunde et al. 2009).

The use value is normally high for plants that are mentioned in several categories by a large number of informants and low for species only used by a few informants.

2.4.2 Statistical analysis

2.4.2.1 Differences in use category based on gender, age and ethnicity From the "informants × species use" category matrix (a), the number of species mentioned by each group of informants in each of the use categories, as well as the total number of species, was calculated. In order to assess differences in the use and local knowledge of woody species based on age (below and above 50 years old), gender (male and female) and ethnic groups (Fulani, Mossi, Samo), the mean number of species in each use category reported per informant group was compared. Differences based on age and gender were assessed using the Mann–Whitney *U* test because of unequal group sizes. Disparities between ethnic groups were analyzed with one-way analysis of variance (ANOVA) for continuous data. The significance level was set a priori to $p = 0.05$. For use categories only very occasionally reported, or with differences that were too large, comparisons between ethnic groups were performed using the nonparametric Kruskal–Wallis test. Mann–Whitney pairwise comparisons were performed for post hoc analysis with a sequential Bonferroni correction for multiple tests (Quinn and Keough 2002). All analyses were carried out using the free statistical software PAST v.2.07 (Hammer and Harper 2008).

2.4.2.2 Variation in local knowledge among ethnic groups The analysis of similarities in plant use between ethnic groups was done using a one-way analysis of similarities (ANOSIM) using Euclidean distances in PAST, based on 9,999 permutations (Hammer and Harper 2008). ANOSIM is a nonparametric multivariate comparison of within and between-group variances. It results in a global test statistic called *R*, which ranges from -1 to 1 with values close to zero indicating no difference between groups. $R < 0.25$ indicates no separation, $0.25 < R < 0.5$ some separation despite a degree of overlap, $R > 0.75$ well separated groups, and $R = 1$ total separation of groups (Clarke 1993). Negative values can occur. The benefit of using ANOSIM in this study was that it enables all six use categories of each ethnic group to be considered together in the analysis. A principal coordinate analysis (PCO) using Euclidean distances was applied to visualize the dissimilarities between the ethnic groups in a Cartesian ordination space.

For the purpose of assessing the effect on plant knowledge of the factors “gender” and “age” nested within the factor “ethnic group,” two-way ANOSIM was performed on the nested factor combination and all six use categories. Two-way ANOSIM was performed using Euclidian distance and 9,999 permutations. Hence, it was possible to test whether the nested factors adequately described clearly separated clusters in multivariate space.

2.4.2.3 Correlations In order to test for correlations between different factors, Spearman rank correlations were calculated between: (1) the use values of the species and the mean ranks of the same species in terms of their considered importance (in this way it was tested whether the species with high use values were correlated with the “most important species”); (2) species abundances as estimated by the informants and the species use values (to test the “apparency hypothesis” (Lucena et al. 2007) according to which dominant species are credited with high use values); and (3) mean ranks of the “most important species” and mean ranks of the species chosen as conservation priorities.

3 Results

3.1 Diversity of woody species and family composition

A total of 90 woody species named by the respondents were collected and identified: 64 species by the Fulani, 74 by the Mossi and 73 by the Samo ethnic groups. The 90 species corresponded to a total of 32 families and 64 genera for the whole study area. Some 32 families were identified by both the Mossi and the Fulani, and 27 by the Samo ethnic group. The most represented plant families were the Mimosoideae (19 %), Caesalpinioideae (10 %), Combretaceae (10 %), Capparaceae (7 %) and the Anacardiaceae (5.5 %) (Fig. 2). Seventeen families were only represented by one species (“Appendix”).

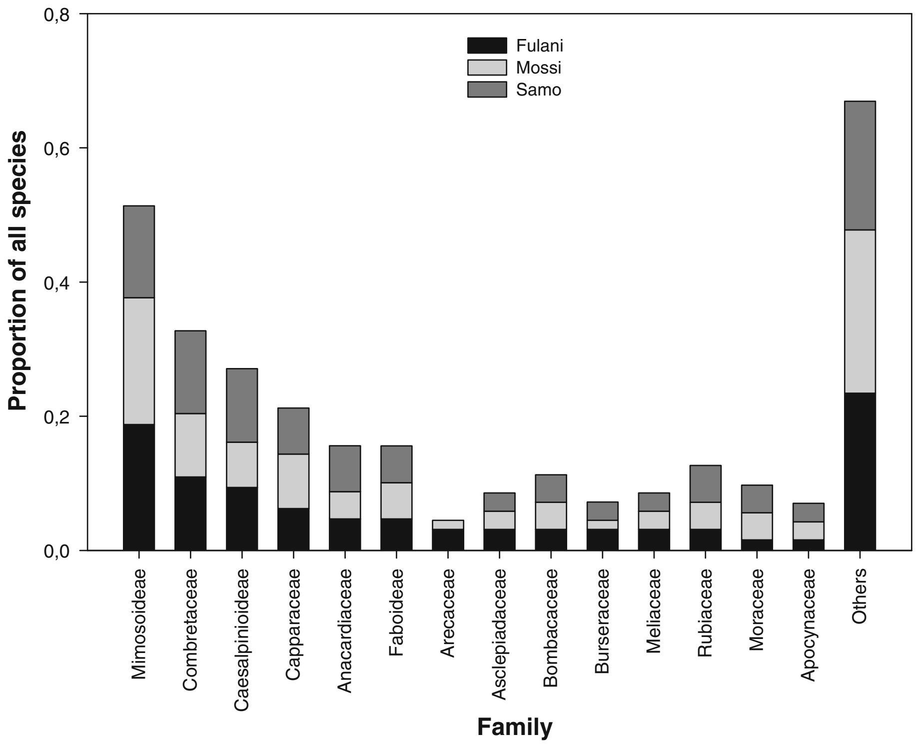

Fig. 2 The most commonly used plant families in the three ethnic groups from the sub-Sahel of Burkina Faso

3.2 Use categories and use patterns of woody species

When data from all ethnic groups were considered together, 90 % of the total number of species were used for energy, 80 % for medicine, 70 % for food, 60 % for fodder, 60 % for construction and 50 % for handicrafts (Fig. 3). The Mossi ethnic group knew the most species used in handicrafts. This decreasing order of importance of use categories was also apparent when considering each ethnic group separately.

Interestingly, the Fulani listed a higher proportion of species used for fodder, energy and construction than the Samo and the Mossi groups. The Samo listed more species used for food, while the Mossi mentioned a greater number of species used in medicine (Fig. 3).

3.3 Effect of gender, age and ethnicity on plant knowledge

3.3.1 Effect of gender

Although there were half as many groups of female informants as the groups of male informants, the mean number of plants cited for each use category and the total number of plants did not significantly differ between genders (Table 2). The same result was found when each ethnic group was analyzed separately.

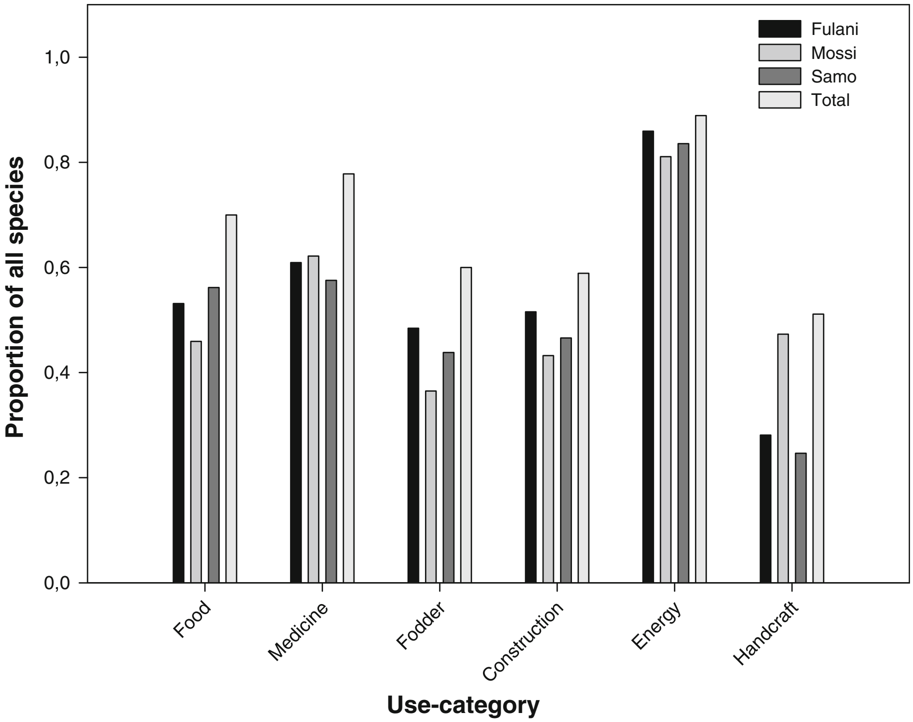

Fig. 3 Distribution of woody plant species in each use category for the three ethnic groups from the sub-Sahelian area of Burkina Faso

3.3.2 Effect of age

Older people (age > 50 years) generally possessed a greater knowledge of plant species than younger people. The number of species listed by respondents of the different age groups showed significant differences in the following categories: food, medicine, fodder, construction and energy (Table 2).

3.3.3 Effect of ethnicity

Considering all use categories, there was a significant difference between the total number of species reported by the three ethnic groups (Kruskal–Wallis test; $H = 28.37, p < 0.001$). When the mean rank of species in each use category was compared across the ethnic groups with the Mann–Whitney U pairwise comparisons (Bonferroni-corrected), differences were found in each case (Table 2). The Fulani listed a lower total number of species in all use categories (Table 2). The number of species cited by the Samo and the Mossi were similar in the categories food, fodder and construction. However, in other categories such as medicine, energy and handicrafts, the number of species differed significantly (Table 2).

3.4 Relative importance of species

The relative importance of each species was derived from its use value. Across the ethnic groups, the five species with the highest use-value indices were: *Balanites aegyptica,*

Table 2 Mean number of woody species (±SD) reported by the informants for different categories of use for the sub-Sahel region of Burkina Faso

	n	Food	Medicine	Fodder	Construction	Energy	Handcraft	Total species
Gender								
Female	30	22.6 ± 4.10	18.4 ± 6.10	14.1 ± 4.2	18.8 ± 4.4	30 ± 8.9	13.1 ± 7.8	39.1 ± 8,20
Male	57	23.4 ± 4.40	17.6 ± 9.10	14.9 ± 4.5	19.5 ± 5.0	32.5 ± 8.8	13 ± 8.0	41.24 ± 9,86
p value		0.32	0.60	0.34	0.43	0.21	0.88	0.25
Age								
< 50	52	22.1 ± 3.6	16.3 ± 7.5	13.8 ± 3.8	18.1 ± 4.6	30.1 ± 8.1	12.3 ± 7.5	36.56 ± 7.70
> 50	35	24.7 ± 4.8	20.2 ± 8.6	15.9 ± 4.9	20.9 ± 4.8	33.9 ± 9.5	14.2 ± 8.4	44.53 ± 9.20
P value		<0.005	<0.05	<0.05	<0.01	<0.05	0.32	<0.001
Ethnicity								
Fulani	26	20 ± 3.9^{a}	11.5 ± 4.7^{a}	10.4 ± 3.2^{a}	13.4 ± 2.6^{a}	24.7 ± 7.8^{a}	4 ± 1.3^{a}	32.69 ± 7.85^{a}
Mossi	29	23.4 ± 3.7^{b}	24.6 ± 8.9^{b}	15.5 ± 3.7^{b}	21.6 ± 3^{b}	29.7 ± 5.5^{b}	22.1 ± 4.8^{b}	41.34 ± 7.88^{b}
Samo	32	25.4 ± 3.6^{b}	17.7 ± 3.4^{c}	17.3 ± 3.2^{b}	21.9 ± 3.1^{b}	39.1 ± 6.3^{c}	12.3 ± 1.9^{c}	46.09 ± 7.19^{b}
p value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Information is based on gender, age and ethnicity. Values with no common superscript in each use category are significantly different ($p < 0.05$)

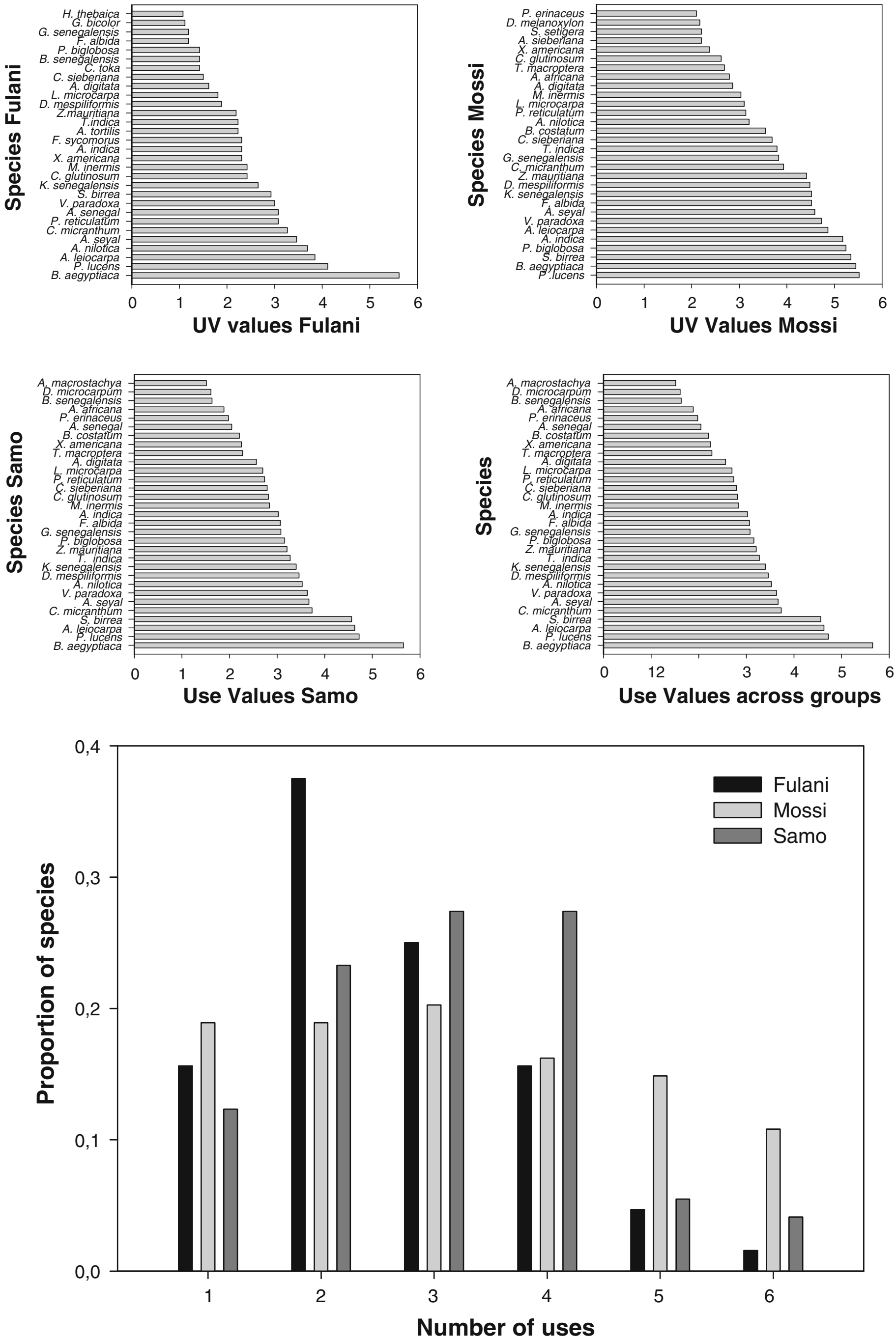

Fig. 4 **a** Mean use values of the 30 most valuable woody species in each ethnic group; **b** Mean number of uses attributed to all recorded species in the three ethnic groups from the sub-Sahel of Burkina Faso

Table 3 Ranking for five of the "most important species"(MIS) and the "Species for conservation priorities" (SCP) in each ethnic group and in general

Species	Study area		Fulani		Mossi		Samo	
	MIS	SCP	MIS	SCP	MIS	SCP	MIS	SCP
Vitellaria paradoxa	1	1	2	3	1	2	1	1
Adansonia digitata	2	2	1	1	2	1	3	5
Parkia biglobosa	3	3	–	–	–	–	2	2
Lannea microcarpa	4	5	5	4	5	4	4	5
Tamarindus indica	5	4	3	2	3	5	5	3
Ziziphus mauritiana	–	–	4	5	–	–	–	–
Bombax costatum	–	5	–	–	4	3	–	4

Spearman corr. MIS-SCP: $r = 0.96$, $p < 0.001$

(–) means not ranked

MIS most important species, *SCP* species for conservation priority

Pterocarpus lucens, Anogeissus leiocarpa, Sclerocarya birrea and *Combretum micranthum*. The first three species were common to all ethnic groups, in the same rank order (Fig. 4a). In all three ethnic groups, a positive correlation was found between the number of different categories of use for each species and their use values (Spearman correlation coefficient, $r_s > 75$, $p < 0.001$). Similarly, a positive correlation was found between the mean number of uses per species and the mean estimated species abundance ($r_s > 0.95$, $p < 0.001$).

3.5 Species importance and priority for conservation

There was overlap between the species identified as being most important by the three ethnic groups (Table 4). While *Ziziphus mauritiana* was only highlighted as important by the Fulani, *Vitellaria paradoxa, Adansonia digitata*, *Tamarindus indica*, *Lannea microcarpa* and *Parkia biglobosa* were the most valuable species to all three communities. Furthermore, the same species were cited by all ethnic groups as priority species for conservation (Table 4). Among the ethnic groups, there was a highly significant and strong correlation between the most important species and the priorities for conservation ($r_s = 0.96$, $p < 0.001$). This was also the case within the Fulani, Mossi and Samo ethnic groups ($r_s = 0.68$, 0.91 and 0.88, respectively; each with $p < 0.001$) (Table 3).

3.6 Variation of plant knowledge among ethnic groups

The ANOSIM multivariate analysis that included all six use categories showed highly significant overall differences in plant use between ethnic groups (global $R = 0.64$, $p < 0.001$, Bonferroni-corrected). ANOSIM pairwise comparisons further revealed that significant differences in plant use exist between ethnic groups: Fulani–Mossi ($R = 0.75$, $p < 0.001$); Fulani–Samo ($R = 0.66$; $p < 0.001$); Mossi–Samo ($R = 0.57$; $p < 0.001$). All the R values fall between 0.50 and 0.75, indicating that despite some similarities in how plants are valued between the three ethnic groups, the groups are largely distinct from each other in multivariate space. This result further indicates that ethnicity influences the use and knowledge of plants in the three communities. Principal component ordination (PCO)

Table 4 Spearman correlation coefficients between: (a) mean use value of species and mean ranking of importance (UV/Import.); (b) mean use values and mean abundance (UV/Abund.); (c) mean ranking of importance and mean ranking of species for conservation priority (Import./Cons.); (d) mean abundance and mean ranking of importance (Abund./Import.)

	UV/Import.	UV/Abund.	Import./Cons.	Abund./Import.
	Correlation coefficients			
Fulani	0.54***	0.26*	0.68***	−0.16
Mossi	0.49***	0.25*	0.91***	0.09
Samo	0.30*	0.26*	0.88***	−0.15
All	0.63***	0.26*	0.96***	−0.02

*** $p < 0.001$; ** $p < 0.05$, * $p < 0.01$

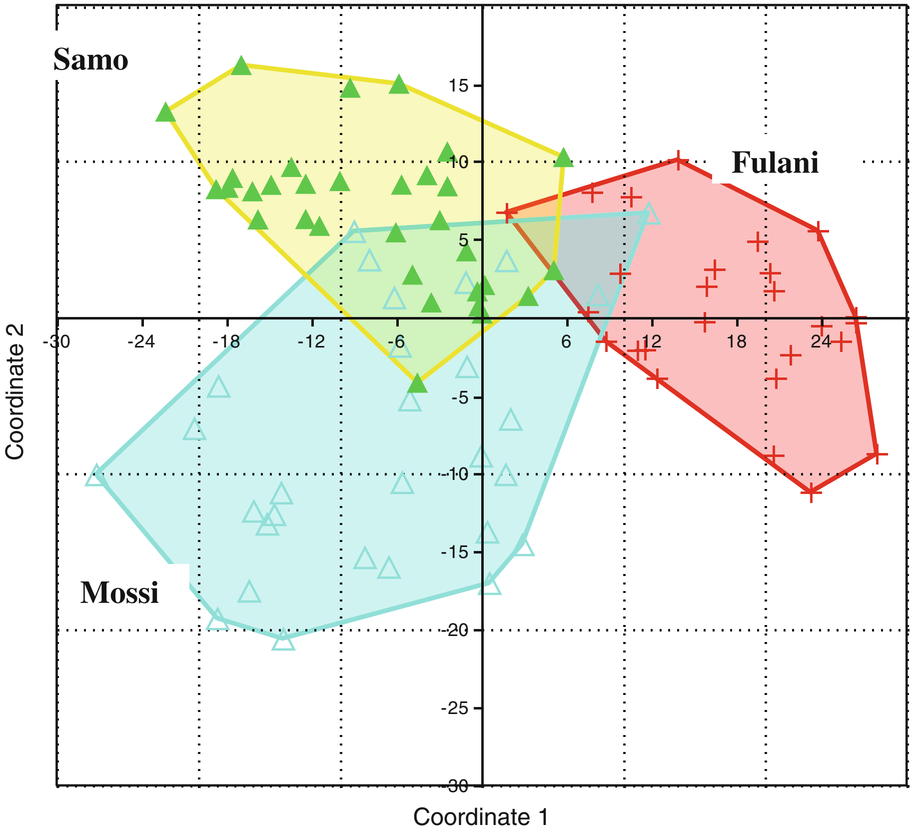

Fig. 5 Principal coordinate ordination (PCO) of the number of species per use category for all informants ($n = 87$). The first and second axes of the PCO are displayed. Eigenvalues: axis 1 = 53 %, axis 2 = 21 %. The *ordination diagram* shows how the three ethnic groups are mostly separated, despite some overlapping

showed that informants with the same ethnicity are clustered, with the clusters slightly overlapping, revealing that the three ethnic groups share some similarity in the use pattern and knowledge of plant species (Fig. 5).

3.7 Correlations

The use values of different species were only weakly correlated with their perceived importance (r_s ranged from 0.30 to 0.54, $p < 0.01$). However, when ethnicity was not taken into account, they became strongly correlated ($r_s = 0.63$, $p < 0.01$) (Table 3). Conversely, no correlation was found between the abundance of species and their perceived importance in any of the ethnic groups (r_s ranging from -0.016 to 0.09; $p > 0.05$). Species' use values and their estimated abundance were weakly correlated ($r_s = 0.26$; $p < 0.01$). Strong correlations existed between species that were perceived as most important and those that were stated as conservation priorities ($r_s > 0.70$, $p < 0.001$).

4 Discussion

4.1 Species richness

A botanical survey conducted in 2008 in the sub-Sahelian sector documented a total of 120 woody plant species in the study area (unpublished data). The present ethnobotanical survey reveals that a total of 90 woody species are used by the three communities targeted in this study. This represents more than 80 % of the total number of woody species found by the main author for that particular region and is an indication of the dependence of the local sub-Sahelian communities on tree-based resources. The recorded number of species is higher than for the North-Sahelian sector (Lykke et al. 2004) and for the woody species reported in the South-Sudanian phytogeographic sector, which is reputed to host the highest diversity of woody plants in Burkina Faso (Taita 2003; Paré et al. 2010). The sub-Sahel does indeed represent the transition zone between the Sahelian and the Sudanian domains and therefore hosts a mixed flora containing Saharian, Sahelian and Sudanian elements (Fontes and Guinko 1995). Its greater species diversity is therefore owed to recruitment from the species pools of neighboring ecosystems.

The total number of species listed by the Fulani was the lowest of the three ethnic groups. This may be the result of three factors. Firstly, the Fulani of West Africa, as herders, are reputed to have a diet based principally on dairy products obtained from the animals they rear. This means that they might not be familiar with the broader spectrum of food species utilized by the Samo and the Mossi. Secondly, fewer Fulani villages were sampled compared with the two other groups. Thirdly, a slight rainfall gradient exists from the east (the Fulani area) to the west (the Samo area) (Fig. 1). Mean annual rainfall recorded over 30 years (1979–2008) for Sebba, upon which the sampled Fulani villages were centered, was 500 mm, compared with 647 mm for Tougan, the main town in the Samo area, and 636 mm and 622 mm for Kaya and Ouahigouya, respectively, the closest weather stations to the sampled Mossi villages. The lower rainfall of the Fulani area may explain its lower species richness. This corroborates the results of an earlier study showing that differences in species between villages were a reflection of ecological and environmental differences driving vegetation dynamics (Lykke et al. 2004). Hence, it is not clear whether lower estimated species richness is a result of a lack of knowledge on the part of the Fulani ethnic group, or of environmental drivers. In the same line, Gouwakinnou et al. (2011) called for a caution while drawing conclusions about the factors affecting the use patterns of a plant, since environmental and context-specific sociocultural factors interact.

4.2 Knowledge and use of plants among ethnic groups

Despite listing fewer species, the Fulani ethnic group reported a higher proportion of species used for food, medicine, fodder, construction and energy than the other groups. The Fulani are herders, and hence, it is not surprising that more woody species would be used for animal fodder compared with the Samo and the Mossi groups. In the Sahelian Zone of Niger, the Fulani were also observed to use more species for fodder than the Djerma, who are predominantly farmers (Ayantunde et al. 2008). The Fulani are (semi-)nomadic, and so, it is likely that individuals have more contact and familiarity with plants than members of other ethnic groups. The Fulani are regularly on the move, building temporary huts and without doubt using a high diversity of plants for numerous subsistence purposes. The Mossi and Samo groups, being sedentary people, can be expected to prefer a more selective range of plant species including woody species with hard-wearing properties suitable for construction.

Most species (80–90 %) are used for firewood by all groups. It was noticed that in the study area, people use everything available to produce energy, except plants that are considered sacred because of their magical/spiritual role in the communities. This is a common pattern reported in the West African Sahel (Lykke et al. 2004; Ganaba et al. 2005).

The next most common use of plants was for medicinal purposes. Between 60 and 80 % of plant species listed were reported to be used for medicine. This is consistent with previous findings (Lykke et al. 2004; Nadembega et al. 2011, Belem et al. 2007). It has previously been observed in Burkina Faso that all plant species are used for diverse purposes in medicine (Belem et al. 2007). In the south, it was noted that 78 % of plants were used for medical care (Taita 2003). This trend has also been reported in other parts of Africa and reflects how dependent people are on medicinal plants for daily health care in the Sahelian area, if not throughout the continent (Cheikhyoussef et al. 2011). Relying on plants for medical care is not a lifestyle choice as in Western countries. It is dictated by the limited economic means of the large majority of the people, who cannot afford science-based medical care or who lack access to medical centers from their remote Sahelian villages.

Few species were mentioned in the handicrafts category as this is a more sophisticated domain that requires certain expertise, and plausibly only a restricted number of species. The Fulani were the least knowledgeable in handicrafts, probably because of their (semi-)nomadic lifestyle. The Mossi, who have a rich tradition as artisans, reported the highest number of species in the crafts category.

4.3 Factors affecting plant knowledge distribution

4.3.1 Age

Older people cited more species than the younger. Many studies in West African semiarid areas have reported that age has a direct bearing on knowledge of plants and plant use (Wezel and Haigis 2000; Paré et al. 2010). Local knowledge of plants tends to accumulate with time and with continued interaction with the natural environment (Ayantunde et al. 2008). Such a pattern has been found in the rural societies of Amazonia (Alexiades 1999). The results of this study failed to confirm the findings of Lykke et al. (2004) in five Fulani villages in the North-Sahelian area of Burkina Faso, where it was found that age was not an important determinant of plant knowledge. Accumulated local knowledge of plants with age cannot be generalized to all societies, as the distribution of plants' knowledge across age classes has also been shown to follow the allocation of social duties. In the Amahara region of Ethiopia, for example, the younger generation (under 30 years old) were more knowledgeable about wild fruits than older generations as a direct result of increased contact with the natural environment (Fentahun and Hager 2009). Therefore, sociocultural factors inherent to each community affect the distribution of local plant knowledge between age classes.

4.3.2 Gender

There was no significant difference in knowledge of plants between genders. All the same, men listed more plants in all categories except medicine, for which women were more knowledgeable. These findings are similar to those of other studies in the Sahel of Burkina Faso (Lykke et al. 2004) and Niger (Ayantunde et al. 2008), but differ from the results of studies carried out in Niger and Mali (Wezel and Haigis 2000; Gakou et al. 1994). Men's superior knowledge of plants had been explained in other contexts by a better access to plant knowledge through the social division of labor (Alexiades 1999).

Generally, local plant knowledge is unequally distributed between genders, with women tending to know more non-woody species, especially fruit trees and medicinal plants, and men knowing more species used for energy generation and construction (Lucena et al. 2007). This observation of women's greater role in the possession and use of medicinal resource knowledge has been explained by their primary role as carers of children, who are most prone to illness (Alexiades 1999).

It is possible that the non-significant differences between men and women in all categories in this study may be due to the relatively low diversity of woody plants of the Sahelian ecosystems of West Africa compared to other semiarid ecosystems such as the Karoo in southern Africa (Ayantunde et al. 2008). In the more diverse vegetation of the South-Sudanian area of Burkina Faso, gender difference in plant use and knowledge has also been noted (Taita 2003; Paré et al. 2010). Species used in construction were better known by men, and species used for food were better known by women.

The results of this study may also be caused by a methodological bias. Whereas other studies used individual interviews for data collection, this study was based on group interviews. It is thought that the cumulative effect of knowledge from different participants with unequal competence in plant knowledge may have blurred the lines of distinction between genders. However, another study found no gender variation in plant use in the North-Sahelian area of Burkina Faso using individual interviews (Lykke et al. 2004). It is possible that a difference in plant knowledge between genders might have been detected if the plant use categories were further subdivided into more specific sub-categories according to the respective principal roles played by each sex in the society. Regardless, with the rapid decrease in plant diversity driven by the progressive replacement of natural vegetation by agroforestry parklands in the Sudano-Sahelian area of Burkina Faso, it is more likely that, apart from very specialized domains such as medicinal plants, local knowledge of plants will be evenly distributed among men and women. Additionally, women have been increasingly taking on duties traditionally undertaken by men, more and more of whom are migrating away from their communities, and even the country, in search of work. This might also explain the homogenization of plant knowledge between males and females.

4.4 Relative importance of species

The use-value technique is widely acknowledged as an objective and reliable tool to quantify the relative importance of a plant species to a community, as it is simultaneously based on the number of uses that are linked to the plant and the number of informants that mention it (Philips et al. 1994). *Balanites aegyptiaca* and *Pterocarpus lucens* were scored as having the highest use values in each ethnic group and as a whole. These species are authentic multipurpose plants that render a large number of services to local communities in the sub-Sahel, in particular during the dry season. Plant use values are said to be most associated with species that fall into multiple categories, even if they are only known by a limited number of people (Albuquerque et al. 2006). Within each ethnic group, several species were allocated high use values while the majority had low use values (Fig. 4a).

The five species with the highest use values were entirely different from those species listed by the informants as "most important." This discrepancy seems to support the assumption that the use-value index does not distinguish between actual and potential uses by informants (Albuquerque and Lucena 2005). This could be problematic in the interpretation of the actual degree of pressure a species, or the vegetation as a whole, is really experiencing (Lucena et al. 2007).

Although species' use values were weakly correlated with their estimated abundance, the latter showed a very strong correlation with the mean number of uses of each plant. This suggests that the relative importance (use value) of a species might directly relate to the number of uses *B. aegyptiaca* had simultaneously the highest overall use value and greatest abundance score, supporting the "apparency hypothesis" that the use of a species might be related to its conspicuousness (Lucena et al. 2007; Camou-Guerrero et al. 2008).

The 30 species with the highest use values showed that the three ethnic groups rely on the same species, but with different intensities of use. The Samo and Mossi seem to possess a similar knowledge about plants, being more diversified than that of the Fulani. This may be an effect of location, which has been shown to homogenize use patterns of plants in neighboring ethnic groups (Gouwakinnou et al. 2011). However, more than half of all the species had more than three uses (Fig. 4b). This suggests that the rural communities of the sub-Sahel value a large spectrum of woody species for several purposes. This might be a consequence of low species richness in their region. In comparison, in the forest ecosystems of Amazonia, with a far higher diversity, most trees have only occasional uses whereas a few species are exceptionally useful and intensively used (Philips et al. 1994).

4.5 Most important species and priority plants for conservation

Many studies have ranked the importance of multipurpose species from the perspective of rural people in the Sudano-Sahelian zone of Burkina Faso. These efforts have led to the same outcome, with *Vitellaria paradoxa, Parkia biglobosa, Tamarindus indica*, *Adansonia digitata, Bombax costatum, Lannea microcarpa* and *Ziziphus mauritiana* always being perceived as the most important species to the rural communities (Hahn-Hadjali and Thiombiano 2001; Kristensen and Balslev 2003; Taita 2003; Nikiema 2005; Paré et al. 2010). The most important species recorded in this study, within and across the groups, are consistent with the above findings. *V. paradoxa, P. biglobosa, T. indica* and *A. digitata* are considered to be the most important wild species in Burkina Faso as well as several other West and Central African countries (Teklehaimanot 2004; Jama et al. 2008; Faye et al. 2010). Clearly, the criteria that lead to the selection of these species are their nutritional and socioeconomic value to rural households (Nikiema 2005). They provide a number of ecosystem services and are important sources of income for rural people in many parts of Burkina Faso. For this reason, they are protected in agroforestry parklands, where they are mainly preserved and maintained in cultivated fields (Bayala et al. 2008). Most of these wild plants are made available in times of critical food shortages and generally provide high amounts of essential nutrients. Wild fruits in general have a substantial potential for diversifying food sources and ameliorating shortages from current nutritional sources (Fentahun and Hager 2009).

The most important species were also considered of high priority for conservation by all ethnic groups, and this was also in line with the findings of Kristensen and Balslev (2003) among the Gourounsi people in southern Burkina Faso. The strong correlation between the two categories further highlights and strengthens the significance of these species to the local people.

Apart from *Parkia biglobosa*, which had the fourth highest use value in the Mossi group (Fig. 4a), none of the species considered to be most important were ever ranked in the top five use-value indices. This could suggest that from the perspective of the local people, the importance of a species is not only defined by the multiple or potential functions it can offer, but mostly by its ability to provide food or nutrients in the precarious environment of the Sahel, which is prone to drought-induced famines. Further, scholars have underlined that one of the main weakness of the use value technique is its failure to separate present use ("real use") from past use ("cognitive use") (Albuquerque and Lucena 2005). This may also well explain the discrepancy between the use values of species and their perceived importance.

However, the vulnerability of these species is of major concern. *V. paradoxa, P. biglobosa, T. indica*, *A. digitata* and *B. costatum* in particular are under threat, facing population declines mainly due to regeneration failure, population aging, drought and human pressure (Sop and Oldeland in press). Therefore, decision makers and non-governmental organizations (NGOs) should support conservation strategies for these species, as they are crucial to poverty alleviation in rural areas. Research has also a great role to play in the domestication of these plants through the development of simple vegetative propagation methods to improve their productivity and availability.

4.6 Overall differences in plant use and local knowledge

One of the most widely reported factors likely to result in a difference in the use of plants between different communities is ethnicity (Gouwakinnou et al. 2011). ANOSIM revealed a clear dissimilarity in overall knowledge of plants between ethnic groups. This suggests an unequal valuation of plant resources by the Fulani, the Mossi and the Samo. Cultural settings or ethnicity cannot solely explain the differences observed in plant knowledge between the groups. Other factors such as local environmental conditions might also play a role. Different environmental and context-specific sociocultural factors determine the use patterns of plant species by communities, including culture (ethnicity), geographic location, intercultural mixing with neighboring groups and local availability of the targeted species (Gouwakinnou et al. 2011). In this study, variability of rainfall and related vegetation characteristics among the ethnic areas had, most certainly, played a role in knowledge differentiation among the groups. Differences in use patterns of *Adansonia digitata* and *Scleocarya birrea* were found between various ethnic groups in northern Benin (De Caluwé et al. 2009; Gouwakinnou et al. 2011). Contrary to the results of this study, no ethnic effect on the use of woody plants in Niger was observed (Ayantunde et al. 2009).

5 Conclusion and implications for conservation

The aim of this study was to carry out an ethnobotanical survey of all woody plants species used in three ethnic communities across the sub-Sahelian phytogeographical region of Burkina Faso. In addition, the variation in knowledge of plants among communities, as well as the driving factors behind this variation, was also investigated. This research has highlighted how wild plants still serve multiple purposes and remain an important resource pool for rural communities. Differences in plant knowledge were found and could be explained by cultural differences and variability in local ecological and environmental conditions. Within ethnic groups, no gender differentiation of plant knowledge was found. However, age was seen to be an important factor, with older people being better than the younger in the acquisition and consolidation of local knowledge of plants in the sub-Sahel.

The survey identified a set of species considered to be most important to local communities: *Vitellaria paradoxa*, *Adansonia digitata, Tamarindus indica, Parkia biglobosa, Lannea microcarpa*, *Bombax costatum* and *Ziziphus mucronata.* These plants were also identified as being priorities for conservation due to their key role in the rural economy of the sub-Sahel. Most of these species are still un- or semidomesticated, slow to regenerate and facing a rapid decline in their natural populations. Policy makers and development agencies should address and integrate local people's species preferences and conservation priorities in their global strategy for poverty relief. The development of vegetative propagation methods, improvement of tree food production potential and nutriment supply is strongly recommended. This needs to be through the development of new varieties of these plants, with shorter life cycles, which are able to persist during periods of drought in the Sahel.

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Appendix

See Table 5.

Table 5 List of species mentioned by the informants of all ethnic groups and their use categories

Species name	Family/Subfamily	Ethnic group	Use category
Acacia ataxacantha DC.	Fabaceae–Mimosoideae	1	Fo.
Acacia dudgeoni Craib ex Hall.	Fabaceae–Mimosoideae	1, 2	F, Fo., C, E
Acacia erythrocalyx Brenan (L.) Willd.	Fabaceae–Mimosoideae	1, 2, 3	Fo., E
Acacia laeta R.Br. ex Benth.	Fabaceae–Mimosoideae	1	Fo., C, E
Acacia macrostachya Rchb. ex DC.	Fabaceae–Mimosoideae	1, 2, 3	F, Fo., E
Acacia nilotica (L.) Willd. ex Del.	Fabaceae–Mimosoideae	1, 2, 3	F, M, Fo., C, E, H
Acacia senegal (L.) Willd.	Fabaceae–Mimosoideae	1, 2, 3	F, M, Fo., C, E, H
Acacia seyal Delile	Fabaceae–Mimosoideae	1, 2, 3	F, M, Fo., C, E, H
Acacia sieberiana DC.	Fabaceae–Mimosoideae	1, 2, 3	M, Fo., C, E, H,
Acacia sp.	Fabaceae–Mimosoideae	2	F, Fo., C, E,

Table 5 continued

Species name	Family/Subfamily	Ethnic group	Use category
Acacia tortilis (Forssk.) Hayne	Fabaceae–Mimosoideae	1	Fo., C, E, H
Adansonia digitata L.	Bombacaceae	1, 2, 3	F, M, Fo., E, H
Afzelia africana Smith ex Pers.	Fabaceae–Caesalpinioideae	1, 2, 3	F, Fo., C, E, H
Albizia chevalieri Harms.	Fabaceae–Mimosoideae	1, 2	Fo., C, E, H
Annona senegalensis Pers.	Annonaceae	1, 2, 3	F, M, E
Anogeissus leiocarpa (DC.) Guill. et Perr.	Combretaceae	1, 2, 3	F, M, Fo., C, E, H
Azadirachta indica A. Juss.	Meliaceae	1, 2, 3	F, M, Fo., C, E, H
Balanites aegyptiaca (L.) Del.	Balanitaceae	1, 2, 3	F, M, Fo., C, E, H
Bauhinia rufescens Lam.	Fabaceae–Faboideae	1, 2, 3	M, Fo., C, E
Bombax costatum Pellegr. et Vuillet.	Bombacaceae	1, 2, 3	F, M, Fo., E, H
Borassus aethiopum Mart.	Arecaceae	1	F
Boscia angustifolia A. Rich.	Capparaceae	2, 3	F, M, Fo., E
Boscia senegalensis (Pers.) Lam. ex Poir.	Capparaceae	1, 2, 3	F, M, Fo., E
Boswellia dalzielii Hutch	Burseraceae	1, 2, 3	M, C, E
Burkea africana Hook.	Fabaceae–Caesalpinioideae	3	M, Fo., C, E
Cadaba farinosa Forssk.	Capparaceae	2	C
Calotropis procera (Ait.) Ait. f.	Apocynaceae	1, 2, 3	F, M
Capparis sepiaria L.	Capparaceae	1, 2, 3	F
Cassia occidentalis L.	Fabaceae–Caesalpinioideae	1	M
Cassia siamea Lam.	Fabaceae–Caesalpinioideae	3	M, C
Cassia sieberiana DC.	Fabaceae–Caesalpinioideae	1, 2, 3	M, Fo., C, E, H
Ceiba pentandra (L.) Gaerth	Bombacaceae	2, 3	F, M, Fo., E, H
Celtis toka (Forssk.) Hepper & Wood	Ulmaceae	1, 2	F, M, Fo., E
Combretum aculeatum Vent.	Combretaceae	1, 2, 3	M, Fo., H
Combretum adenogonium Steud. ex A.Rich.	Combretaceae	3	C, E, H
Combretum glutinosum Perr. ex DC.	Combretaceae	1, 2, 3	M, Fo., C, E, H
Combretum micranthum G. Don	Combretaceae	1, 2, 3	M, Fo., C, E, H
Combretum nigricans Lepr. ex Guill. et Perr.	Combretaceae	1, 2, 3	C, E, H
Commiphora africana (A. Rich.) Engl.	Burseraceae	1, 3	M, Fo.
Crateva adansonii DC.	Capparaceae	1, 2, 3	F, E, H
Dalbergia melanoxylon Guill. et Perr.	Fabaceae–Faboideae	2, 3	F, M, C, E
Detarium microcarpum Guill. et Perr.	Fabaceae–Caesalpinioideae	2, 3	F, M, C, E, H
Dichrostachys cinerea (L.) Wight et Arn.	Fabaceae–Mimosoideae	1, 2	M, E
Diospyros mespiliformis Hochst ex A. DC.	Ebenaceae	1, 2, 3	F, M, C, E, H
Entada africana Guill. et Perr.	Fabaceae–Mimosoideae	2, 3	M, Fo., C, E
Eucalyptus camaldulensis Dehnh.	Myrtaceae	1, 2	M, C, E, H
Faidherbia albida (Del.) A. Chev.	Fabaceae–Mimosoideae	1, 2, 3	F, M, Fo., C, E, H
Feretia apodanthera Del.	Rubiaceae	1, 2, 3	M, Fo., C, E
Ficus ingens (Miq.) Miq.	Moraceae	2	F
Ficus platyphylla Delile	Moraceae	2, 3	F, E
Ficus sp.	Moraceae	3	F
Ficus sycomorus L.	Moraceae	1, 2, 3	F, M, C, E

Table 5 continued

Species name	Family/Subfamily	Ethnic group	Use category
Gardenia erubescens Stapf et Hutch	Rubiaceae	3	F, E
Gardenia sokotensis Hutch.	Rubiaceae	2, 3	F, E
Grewia bicolor Juss.	Tiliaceae	1, 2, 3	F, Fo., C, E
Guiera senegalensis J. F. Gmel.	Combretaceae	1, 2, 3	M, C, E, H
Gymnosporia senegalensis (Lam.) Loes	Capparaceae	2, 3	F, M
Holarrhena floribunda (G. Don) Dur et Schinz	Apocynaceae	1, 2	M
Hyphaene thebaica (L.) Mart.	Arecaceae	1, 2, 3	F, E
Khaya senegalensis (Desr.) A. Juss.	Meliaceae	1, 2, 3	M, Fo., C, E, H
Lannea acida A. Rich	Anacardiaceae	1, 2, 3	F, M, C, E, H
Lannea microcarpa Engel. et K. Krause	Anacardiaceae	3	F, M, C, E, H
Lannea velutina A. Rich	Anacardiaceae	1, 2, 3	F, C, E
Leptadenia hastata (Pers.) Decne.	Apocynaceae	1, 2, 3	F, M, Fo.
Maerua crassifolia Forssk.	Capparaceae	1, 2, 3	F, M, Fo., E
Mitragyna inermis (Willd.) Kuntze	Rubiaceae	1, 2, 3	M, Fo., C, E, H
Moringa oleifera L.	Moringaceae	1, 3	F, E
Ozoroa obovata (Oliv.) R.Fern. & A.Fern.	Anacardiaceae	3	M
Parkia biglobosa Jacq. R. Br. ex G. Don	Fabaceae–Mimosoideae	1, 2, 3	F, M, Fo., C, E, H
Piliostigma reticulatum (DC.) Hochst.	Fabaceae–Caesalpinioideae	1, 2, 3	F, M, Fo., E
Piliostigma thonningii (Schumach.) Milne-Redh.	Fabaceae–Caesalpinioideae	3	M, Fo.
Prosopis africana (Guill. & Perr.) Taub.	Fabaceae–Mimosoideae	2	C, E
Pteleopsis suberosa Engl. et Diels	Combretaceae	3	C, E
Pterocarpus erinaceus Poir.	Fabaceae–Faboideae	1, 2, 3	F, M, Fo., C, E, H
Pterocarpus lucens Lepr. ex Guill. & Perr.	Fabaceae–Faboideae	1, 2, 3	F, M, Fo., C, E, H
Saba senegalensis (A.DC.) Ait. f.	Apocynaceae	1, 2, 3	F, M
Sclerocarya birrea (A. Rich.) Hochst	Anacardiaceae	1, 2, 3	F, M, Fo., C, E, H
Securidaca longepedunculata Fres.	Polygalaceae	1, 2, 3	M
Sterculia setigera Del.	Sterculiaceae	1, 2, 3	M, C, E, H
Stereospermum kunthianum Cham.	Bignoniaceae	2, 3	M, Fo., C, E
Strychnos spinosa Lam	Strychnaceae	1, 2	F,
Tamarindus indica L.	Fabaceae–Caesalpinioideae	1, 2, 3	F, M, C, E, H
Agelanthus dodoneifolius (DC.) Polhill & Wiens	Loranthaceae	2, 3	M
Terminalia macroptera Guill. et Perr.	Combretaceae	1, 2, 3	M, C, E, H
Vernonia colorata (Willd.) Drake	Asteraceae	2	M
Vitellaria paradoxa C.F.Gaertn.	Sapotaceae	1, 2, 3	F, M, C, E, H
Vitex doniana Sweet	Verbenaceae	1, 2, 3	F, Fo., E
Ximenia americana L.	Olacaceae	1, 2, 3	F, M, C, E
Ziziphus mauritiana Lam.	Rhamnaceae	1, 2, 3	F, M, Fo., C, E, H
Ziziphus mucronata Willd.	Rhamnaceae	2	M, C

1 Fulani, *2* Mossi, *3* Samo, *F* Food, *M* Medicine, *Fo.* Fodder, *C* Construction, *E* Energy, *H* Handcraft

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