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Botanical Knowledge and its Differentiation by Age, Gender and Ethnicity in Southwestern Niger

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Abstract Indigenous knowledge is unevenly distributed. Individual knowledge level may be affected by many factors such as gender, age, ethnicity, profession, religious and cultural beliefs, abundance and usefulness of the species. This study documents indigenous knowledge of herbaceous and woody plant species of farmers and herders in southwestern Niger. Specifically, we examine the effects of age, gender, and ethnicity on knowledge of local vegetation. Results from the study showed that on average a higher proportion of woody species was identified by the respondents compared to herbaceous species. Both gender and ethnicity had a significant effect on the identification of herbaceous species but no effect on identification of woody species. Respondents in lower age group (10 to 30 years) identified lower number of species compared to other age classes. There seems to be a curvilinear relationship between age of respondents and number of plant species identified. Results from this study reaffirm the uneven distribution of indigenous knowledge within a given area due to social factors. The main challenge is how to incorporate these social differences in knowledge of native plant species into sustainable management and conservation of community natural resources.

Keywords Indigenous knowledge · Ethnobotany · Vegetation · Gender · West African Sahel · Niger

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Introduction

In the West African Sahel, local vegetation has a central role in the everyday lives of rural people, providing people with food, fuel and medicine, as well as materials for construction and the manufacturing of crafts and many other products (Hamilton *et al.* 2003). Harvesting and processing of various plant products are undertaken by communities in the region to fulfill their various daily needs (Nikiema 2005). Livestock also depend mainly on local vegetation for their fodder. The rich knowledge of farmers and herdsmen of their local environment (vegetation, livestock species, agroforestry etc.) is widely acknowledged (Grenier 1998; Ayantunde *et al.* 2007). A good understanding of local knowledge[1] of native herbaceous and woody species will enhance sustainable natural resource management. In addition, an understanding of local knowledge of native plant species can guide identification of research priorities for better and sustainable management of natural resources. Failure of many natural resource management and conservation projects in the region can be partly

[1] Local knowledge refers to indigenous knowledge which is defined by Warren (1991) as knowledge that is unique to a given culture or society. Broadly speaking, it may be defined as knowledge used by local people to make a living in a particular environment. In this paper, the terms local knowledge and indigenous knowledge are used interchangeably.

attributed to lack of such understanding. For instance, the protected areas approach to conserve certain plant species in the West African Sahel has not been successful in many rural communities because it excludes most people from using the plants (Nikiema 2005).

Indigenous knowledge of natural resources in a community varies according to individual attributes of age, education, gender, ethnicity, social and economic status, roles and responsibilities in the home and community, profession, aptitude and intellectual ability, and control over natural resources (Berkes 1993; Grenier 1998; Antweiler 1998; Holt 2005). Gender specificity of local knowledge stems from economic and political structures in a community, gender bias in instruction of children and occupational differentiation along gender lines (Simpson 1994; Grenier 1998). Thus, women's and men's knowledge reflect their upbringing and labor responsibilities. To generalize local knowledge along gender lines even within the same community can be misleading. Such generalization in the past has been blamed for the failure of many development interventions because most technologies and technology transfers are not gender neutral (Grenier 1998). Local knowledge can also be differentiated along ethnic lines (Turner and Hiernaux 2002). For example, in the West African Sahel, the Peulh, Kel Tamashek, Bellah, and Maure are the major livestock-rearing groups while farmers are mainly from the Bambara, Hausa, Djerma, Gourmantche, Mossi and Soninke (Turner and Hiernaux 2002). We should emphasize that occupational specialization along ethnic lines is getting increasingly blurred in the region (Turner and Hiernaux 2002). Nevertheless, the pastoral groups generally know more about livestock husbandry than the farming groups.

In view of gender bias and the possible effect of ethnicity on indigenous knowledge, research aimed at engaging local knowledge systems must capture the different sets of knowledge. This necessitates proper documentation of indigenous knowledge, also necessary in view of rapid dynamics of the social, cultural, ecological and economic processes, which the majority of local communities experience every day. Preservation of the cultural identity of a community requires that local knowledge be passed from generation to generation. The growing disinterest of young people in indigenous or local innovations and practices in agriculture, and the migration of rural people to urban areas also reinforce the need for documentation of indigenous knowledge (Berkes 1993; Morrison *et al.* 1996). However, it needs to be made clear that documentation of local knowledge is by no means an end in itself.

This study documents indigenous knowledge of farmers and herders of herbaceous and woody plant species in southwestern Niger. Past ethnobotanical studies in the West African Sahel have focused mainly on woody plant species (Cissé 1995; Sow and Anderson 1996; Diop *et al.* 2005) but in our study we included herbaceous plants in view of their importance as food for humans and as the main source of forage for animals. The objectives of our study were to document indigenous knowledge of herbaceous and woody plant species in southwestern Niger, and to assess the effects of age, gender, and ethnicity on botanical knowledge. Individual knowledge level of native plant species may be affected by many factors such as gender, age, ethnicity, profession, religious and cultural beliefs, and abundance and usefulness of the species (Chazdon and Coe 1999). In this study we tested three hypotheses. First, that indigenous knowledge is positively correlated with age, that is, older people will know more of the plant species in their local environment than younger people. Second, that ethnic group or tradition influences environment/ecological knowledge, so that pastoralists (the Peulh ethnic group) will tend to know forage plant species better than farmers (the Djerma ethnic group). And third, that indigenous knowledge of plant species is often strong for species that are in common use by the local community. In this respect, woody plants will be better known than the herbaceous plants since they are used for multiple purposes.

Materials and Methods

Study Site

Fieldwork was conducted from April to November 2005 in three agropastoral territories, namely Banizoumbou, Tigo Tegui and Kodey in Kollo District, Southwestern Niger, which lies between the confluent valleys of the Niger River to the west and fossil valley of the Dallol Bosso to the east (13°20′–13°35′ N; 2°35′–2°52′ E). The study site, described in detail by Turner & Hiernaux (2002), is located in Fakara region of southwestern Niger, which is part of central Sahel bioclimatic zone. The climate of Fakara is a typical upland semiarid tropical climate with an average annual rainfall of 560 mm (1905 to 1989; Lebel *et al.* 1997). Rainfall distribution is strictly monomodal, mostly between July and October. The study site covers 500 km^2 and is populated mainly by the Djerma ethnic group, who are historically land cultivators. Fakara also harbors a significant number of the Peulh (Fulani) people, who are pastoralists but are increasingly becoming engaged in farming. The Peulh have generally settled outside Djerma villages on plots of land loaned to them by Djerma landowners (Turner and Hiernaux 2002). In 1998, the population of the study site was 6000 inhabitants (Hiernaux and Ayantunde 2004). The three agropastoral territories where the survey was conducted are experiencing different

land use pressures, with Kodey having a high proportion of land cropped (65% in 1996) compared to 25% and 39% for Banizoumbou and Tigo Tegui, respectively (Turner and Hiernaux 2002). The vegetation of the study site is composed of two main components: the herbaceous layer dominated by long cycle annual grasses, and a scattered population of small trees and shrubs (Hiernaux and Ayantunde 2004). Unlike other arid ecosystems, perennial grasses and under-shrubs are not common. The severity and long duration of the dry season inhibits perennial grasses, while the seasonal regularity of the rains favors annual plants.

Ethnic Groups in the Study Site

The Djerma are the second largest ethnic group in Niger (about 21% of the total population), following the Hausa. The Djerma rural economy is largely dominated by subsistence agriculture. The main crops grown on their fields, which are controlled by the, predominantly male, household head, are millet, sorghum and cowpea. On individual fields the women grow groundnuts, various kind of vegetables and, on the banks of the river Niger, wet rice. Though predominantly farmers, many Djerma own small herds of cattle, sheep and goats. During the growing season, the animals are generally given to Peulh herdsmen who take care of them against payment in kind or in exchange for land. The Djerma form the majority of the population in Fakara and they largely control land ownership (Turner and Hiernaux 2002).

The Peulh ethnic group accounts for about 10% of Nigers total population (Vennemann 2000) and are found throughout the country. In rural areas, the Peulh place their main emphasis on extensive livestock keeping, complemented by subsistence production of millet and sorghum. However, for the Peulh most prestige is derived from keeping cattle. In Fakara, the Peulh have settled in camps in the vicinity of Djerma villages, where in addition to livestock rearing, many grow crops mainly millet and cowpea. They account for about 20% of the population in the study site (Turner and Hiernaux 2002).

Ethnobotany Survey

Specimens of herbaceous and woody plant species in Fakara were collected between September and October 2004 by a research technician who has been conducting vegetation surveys in the study site since 1994. To ensure collection of as many plant species as could be found in the study site, the research assistant was accompanied by a local guide who is highly knowledgeable of the local vegetation. One hundred and twenty three plant species were collected consisting of 87 herbaceous and 36 woody plant species. In view of interannual fluctuations in floristic composition that normally characterize annual-dominated Sahelian vegetation (Hiernaux and Ayantunde 2004), some annual herbaceous species might have been left out of our collection. However, we believe that the number was low and would not have altered our data significantly. The year we conducted the study (2004) actually had quite a high number of annual herbaceous species (87) compared to the average of 72 species recorded from vegetation surveys of the study site between 1994 and 2003 (Hiernaux and Ayantunde 2004). Interannual fluctuations in floristic composition do not apply to woody plant species. The collected plant species were preserved in the herbarium, which was used for the individual interviews. The interviews were guided by a semistructured questionnaire. In each interview session, an interviewee was shown the plant species collected and was asked to identify each of them. For each plant species that was identified by the interviewee, questions were asked about use, habitat, and perception on the past and present population status of the plant species. Questions on the habitat focused on where the plant species is normally found. On the perception of the past and present population status of the plant species, we asked if the species has increased, decreased or remain unchanged in the last decade. The use of the correct local name(s), either in Zarma (Djerma's language) or Fulfulde (Peulh's language) of a plant species by the interviewee was adjudged as a correct identification of the plant. For the local names of the plant species used, we followed the dictionary of plants in Niger by Peyre de Fabregues (1977). To assess the effects of age, gender and ethnicity on knowledge of local plant species, the selection of respondents for the survey was based on a stratified random sampling technique defined by ethnic group, gender and age. Two ethnic groups (Djerma and Peulh), two gender groups (male and female) and two age groups (adult and young), were interviewed in Banizoumbou, Tigo Tegui and Kodey territories of Fakara (see Table 1 for the details on the eight groups interviewed). We defined adult respondents as those who are married, and the young as those who are unmarried. Thus, we defined marital status as an estimation of age. In total, 209 respondents were interviewed in the three territories. We did not have a sufficient number (only four) of Peulh young (unmarried) females for the interview. Three enumerators fluent in the languages of the interviewees (Zarma and Fulfulde) administered the questionnaire.

Analysis of Survey Data

Data analysis was performed with SAS (1987) using frequency procedure for the description of the data and to analyze the relationships among the variables. ANOVA procedure in SAS was used to analyze data on number of species identified by the different groups, gender, ethnicity,

Table 1 Ethnicity, marital status, age (mean±standard error) and education level of different groups of respondents

Group	Number interviewed	Ethnicity	Gender	Marital status	Age	Education level (number of respondents)			
						Illiterate	Primary	Secondary	Koranic
1	30	Djerma	Male	M	40.6±0.3	13	7	1	9
2	30	Djerma	Male	U	20.7±0.1	10	9	3	8
3	29	Djerma	Female	M	38.8±0.4	23	2	0	4
4	29	Djerma	Female	U	17.6±0.1	17	4	0	8
5	30	Peulh	Male	M	40.4±0.3	17	1	0	12
6	27	Peulh	Male	U	20.8±0.2	16	5	0	6
7	30	Peulh	Female	M	27.7±0.2	25	0	0	5
8	4	Peulh	Female	U	15.2±0.1	4	0	0	0

M married, *U* unmarried

education level, marital status and age class. A test of significance among respondents' groups, gender, ethnic group, education level, marital status, and age class was performed using Tukey's studentized range test (HSD) on all main effect means in the ANOVA statement. For all analysis, the data on Peulh young females were excluded because of the small number of respondents in this group (Table 1). Unless otherwise specified, the level of significance was declared at $P<0.05$.

Results and Discussion

Effect of Age on Indigenous Knowledge of Plant Species

In our study, respondents in the lower age group (10 to 30 years) identified a lower number of species compared to the adult age class for both ethnic groups (Table 2). There seems to be a curvilinear relationship between age of respondents and number of plant species identified for both ethnic groups (Table 2). This suggests that knowledge of plant species drops after a certain age. The common practice of older Peulh men of shifting herding responsibilities to the younger ones (Turner and Hiernaux 2002) might have contributed to their recognition of a lower number of species as they may no longer be up-to-date in their knowledge of local vegetation, which is often characterized by change in floristic composition due to dominance of annual herbaceous species (Breman and de Wit 1983; Hiernaux and Ayantunde 2004).

Generally, the Peulh recognized more species than the Djerma, particularly at the younger age of between 10 and 30 years (Table 2). The exception was a 17 year old Djerma girl who identified the highest number of species (85 out of 123 specimens). We learnt that this girl has been living with her grandmother, a traditional healer, since her childhood and thus acquired her extensive knowledge of local plant species. Higher recognition of plant species by young Peulh compared to young Djerma could be attributed to their year-round involvement in livestock herding, which provides greater exposure to local vegetation. The Djermas' real contact with the local vegetation is during the 4 month cropping season, after which a significant proportion of young men go on temporary migration to neighboring coastal countries such as Nigeria, Côte-D'Ivoire, Ghana and Benin (Lamers and Feil 1995). The highest number of species was recognized by Djerma and Peulh respondents in the age classes of 41–50 and 31–40 years, respectively (Table 2). This implies that Peulh's knowledge of local

Table 2 Number of total plant species (mean±standard error) identified by different age class (year) per ethnic group (Djerma and Peulh)

Age class	Djerma		Peulh	
	Number of respondents	Number of species	Number of respondents	Number of species
10–20	51	49.1 ± 1.8^{a}	20	55.1 ± 2.4^{a}
21–30	26	54.6 ± 1.8^{ab}	37	57.3 ± 1.5^{ab}
31–40	20	55.7 ± 3.0^{ab}	14	64.9 ± 3.9^{b}
41–50	9	61.1 ± 2.9^{b}	8	59.0 ± 4.2^{ab}
51–60	8	54.3 ± 2.3^{ab}	4	59.0 ± 5.9^{ab}
61–80	5	60.6 ± 4.0^{ab}	3	55.0 ± 6.2^{a}

Mean values with no common superscript for each column differ significantly ($P<0.05$) according to Tukey's studentized range (HSD) test in ANOVA. Total number of plant species used for the interview was 123, consisting of 87 herbaceous and 36 woody plant species

Table 3 Number of plant species (mean ± standard error) identified by the respondents for different use category sorted by gender, ethnicity, marital status and education level

Category	Number of respondents	Medicine	Food	Forage	Construction	Firewood
Gender						
Male	116	21.8±0.8[a]	15.6±0.3[a]	52.1±1.1[a]	15.9±0.5[a]	19.9±0.5[a]
Female	89	21.9±0.9[a]	15.8±0.3[a]	46.3±1.3[b]	12.8±0.5[b]	16.6±0.6[b]
Ethnicity						
Djerma	119	22.6±0.9[a]	16.2±0.3[a]	46.6±1.1[a]	15.9±0.5[a]	19.1±0.5[a]
Peulh	86	20.8±0.7[a]	15.0±0.3[a]	53.6±1.2[b]	12.7±0.5[b]	17.6±0.6[a]
Marital status						
Married	121	24.2±0.7[a]	15.8±0.3[a]	51.4±1.1[a]	14.6±0.5[a]	19.0±0.5[a]
Unmarried	84	18.4±0.8[b]	15.6±0.4[a]	46.8±1.3[b]	14.5±0.6[a]	17.8±0.6[a]
Education level						
Illiterate	128	20.8±0.7[a]	15.3±0.3[a]	49.1±1.1[a]	14.7±0.4[a]	17.8±0.5[a]
Primary	21	23.7±2.3[a]	16.5±0.8[a]	47.6±2.5[a]	17.2±1.2[a]	20.6±1.4[a]
Secondary	4	24.3±2.4[a]	15.7±0.9[a]	50.0±3.3[a]	17.3±2.2[a]	24.5±2.9[a]
Koranic	52	23.3±1.3[a]	16.4±0.4[a]	51.9±1.7[a]	15.4±0.8[a]	18.8±0.8[a]

Mean values with no common superscript for each use category differ significantly ($P<0.05$) according to Tukey's studentized range (HSD) test in ANOVA

species peaked much earlier than for the Djerma. It could be speculated that the probable faster aging, with the associated memory loss among the Peulh is due to the laborious and energy-intensive nature of year-round livestock herding compared to the Djerma, whose cropping labor exertion is seasonal, at most 4 months per year. Early retirement from livestock herding compared to Djerma, who can continue farming till much older age, might be another explanation.

Married respondents identified more medicinal and forage plants than unmarried (Table 3). This may partly be due to being older and thus having longer experience in the use of medicinal and forage plants. Besides, at marriage many men and women assume different kinds of duties, which may influence their relationships with plants. For example, in our study site, older people are mainly responsible for health care of the household, which might have given them more contact with medicinal plants than the young.

Education level had no effect on the number of herbaceous and woody species identified for different uses (Table 3). This could be attributed to the generally low level of education of all the respondents (Table 1), which implies that they had not stayed away from their local environment for any significant length of time.

Gender Effects on Indigenous Knowledge of Plant Species

A significant difference was found in the number of herbaceous species and total number of species identified by males and females but no difference in the number of woody species identified (Table 4). The significantly higher number of herbaceous species recognized by men might have been influenced by the higher number of men interviewed. Nevertheless, it is expected that men would recognize more herbaceous species than women since most herbaceous species are grazed by livestock and herd management, especially grazing is men's responsibility. The main role of women in pastoral society centers around livestock products. A similar result was reported for an ethnobotany survey conducted in northern Nigeria for leguminous species (Ricker 2002). Different results may be found in pastoral communities where women are actively involved in herd management, as the case in East Africa, for example among Rendille pastoralists in

Table 4 Number of plant species (mean±standard error) identified by the respondents sorted by gender, ethnicity, marital status and education level

Category	# Respondent	Herbaceous	Woody	Total
Gender				
Male	116	36.1±1.1[a]	21.2±0.4[a]	57.3±1.1[a]
Female	89	31.1±1.4[b]	21.5±0.5[a]	52.6±1.3[b]
Ethnicity				
Djerma	119	31.9±1.2[a]	21.2±0.4[a]	53.1±1.1[a]
Peulh	86	36.7±1.3[b]	21.5±0.5[a]	58.2±1.2[b]
Marital status				
Married	121	36.7±1.2[a]	20.8±0.4[a]	57.5±1.0[a]
Unmarried	84	29.9±1.3[b]	22.1±0.5[a]	52.0±1.3[b]
Education level				
Illiterate	128	33.4±1.1[a]	21.1±0.4[a]	54.5±1.0[a]
Primary	21	31.2±3.2[a]	22.1±0.9[a]	53.4±3.0[a]
Secondary	4	33.2±2.5[a]	22.5±1.9[a]	55.7±0.9[a]
Koranic	52	36.3±1.7[a]	21.6±0.6[a]	57.9±1.7[a]

Mean values with no common superscript for each category differ significantly ($P<0.05$) according to Tukey's studentized range (HSD) test in ANOVA

northern Kenya (Beaman 1983). Non-significant difference ($P>0.05$) in the number of woody species recognized by men and women could be attributed to the low number of woody specimens shown in the interview. Besides, the multiple uses of woody species might have facilitated their easy recognition by the respondents irrespective of their sex.

Gender had no effect on the recognition of medicinal and food species (Table 3). Our results fail to confirm the findings by Ricker (2002) in northern Nigeria that women had greater knowledge of medicinal and food plant species. One reason for the difference in our findings could be lower number of plant species used for the interview by Ricker (2002)—55 species compared to 123 in our study. Besides, Ricker's ethnobotany survey focused only on leguminous species whereas our study included both graminae and leguminous species. Our results could not also confirm the general assumption that women know more about food plant species than men. The finding of non-significant differences between men and women's knowledge of food plant species may be attributed to an increase in men's knowledge. It is also possible that gender-divided knowledge is equalizing in these communities over time, and/or that the low number of food plant species found in our study site may be a reflection of low plant diversity in the Sahelian ecosystems in general (Hiernaux and Ayantunde 2004). According to (Hiernaux and Ayantunde 2004), the biodiversity of the Sahel flora and fauna is relatively poor in comparison with other arid or semiarid ecosystems such as the Karoo-Namib in Southern Africa. Gender may have an effect on knowledge of food plant species in other ecosystems especially mangrove forests, which are known for rich biodiversity and where women are mainly responsible for the collection of food plants for household consumption.

Gender had a significant effect in the recognition of species used for forage, construction and firewood with men identifying higher numbers than women (Table 4). It is to be expected that men would recognize more species used for construction than women because they are largely responsible for the felling of trees and collection of herbaceous plants for building homesteads. These results confirm the general assumption that indigenous knowledge of plant species is strong for species that are often used by the local community (Chazdon and Coe 1999). It is unclear why men recognized more species used for firewood than women given that household cooking is mainly a woman's task.

Effects of Ethnicity on Indigenous Knowledge of Plant Species

Ethnicity had a significant effect ($P<0.05$) on the identification of herbaceous species (Table 4). The Peulh who are pastoralists by tradition, identified more herbaceous species than the Djerma, who are by tradition land cultivators. These results confirm differentiation of botanical knowledge along ethnic lines in our study site. However, it is debatable if the Peulh in the West African Sahel will be able to preserve their animal husbandry knowledge for long in view of their increasing sedentarization to cultivate land over the past three decades, and the migration of young Peulh to urban areas (de Verdière 1994). There was no significant difference in the number of woody species identified by the two ethnic groups (Table 4) partly due to the low number of woody plant species used for the interviews and the multiple uses of woody species.

Ethnicity had no significant effect on recognition of species used for medicine, food and firewood (Table 4). However, ethnic group had a significant effect on the number of forage and construction species identified by the respondents. As expected, the Peulh recognized more forage species than Djerma. The reverse was the case for identification of species used for construction by the two ethnic groups. Peulh homesteads in our study site are mainly grass huts consisting of few herbaceous species and are temporary structures because of the frequent relocation of their camps, hence their identification of a lower number of species used for construction compared to the Djerma, whose buildings are often more permanent structures which require the use of many tree species.

Indigenous Knowledge on Use, Habitat and Population Status of Plant Species

Five major use categories of herbaceous and woody species in the study site were identified through the survey, namely medicine for humans and animals, human food, forage for animals, building construction and firewood (Fig. 1). Other minor uses included farm tools, household utensils, traditional furniture, mystical uses, ornaments and decoration, musical instruments and burials. Number of herbaceous and woody species used for medicine and forage were the highest and about the same (Fig. 1). A considerably lower number of species is consumed by humans compared to number used for medicine and animal forage. This was in agreement with observations by Kiambi and Attah-Krah (2003) that very few plant species provide most of people's dietary energy or protein intake.

The most common habitat for herbaceous and woody species in the study location was sand dunes. Sixty percent of herbaceous species and 36% of woody species used for the interviews were found on sand dunes according to the respondents (Fig. 2). Other habitats where the species are found included sandy depression, clay depressions, plateau and marshes. According to respondents, common herbaceous species found on the sand dunes included *Cenchrus biflorus*, *Eragrostis tremula*, *Mitracarpus scaber*, *Ctenium elegans* and *Aristida sieberiana*. Common woody species

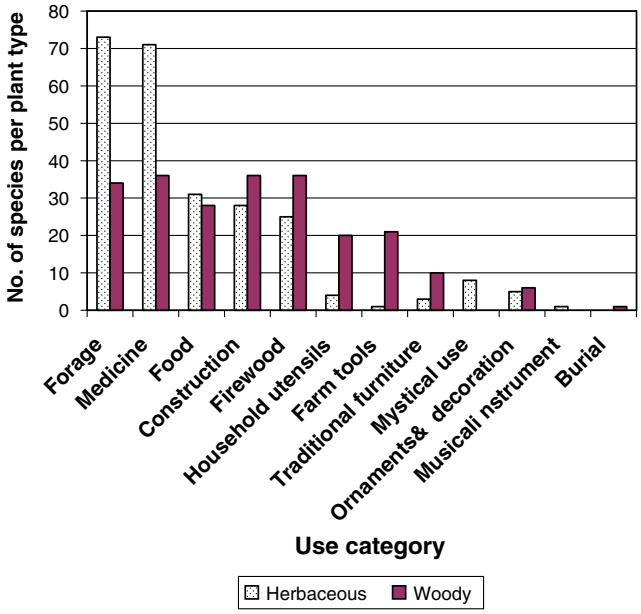

Fig. 1 Different uses of herbaceous and woody plant species in the study site. Five major use categories were identified through the survey namely medicine for human and animal, human food, forage for animals, building construction and firewood

found on sand dunes included *Prosopis africana*, *Combretum glutinosum* and *Acacia nilotica*. Respondents also reported that herbaceous species commonly found on the plateau in the study location included *Zornia glochidiata*, *Pennisetum pedicellatum* and *Blepharis linearifolia*, while *Boscia angustifolia and Combretum micranthum* were woody species commonly found on the plateau. The habitats mentioned by the respondents for most of species

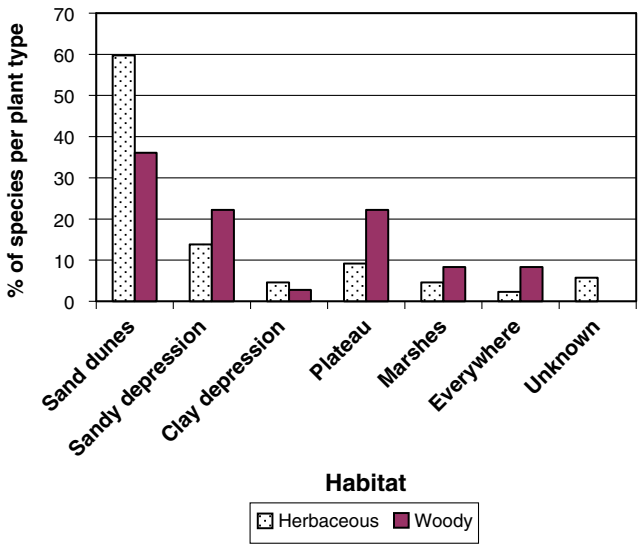

Fig. 2 Habitats of herbaceous (n=87) and woody (n=36) species in the study location according to the respondents' perception. The most common habitat for herbaceous and woody species in the study location was sand dunes

are consistent with the botanical literature (von Maydell 1983; Merlier and Montegut 1982), which confirms the reliability of the ecological knowledge of the rural populations. However, there were a few species, such as *Acacia pennata*, *Pergularia tomentosa*, *Hyphaenea thebaica, Azadirachta indica* for which respondents reported habitats at variance with the botanical literature. For example, *Acacia pennata* was reported to be found on the plateau but in the literature (von Maydell 1983; Merlier and Montegut 1982) its habitat is reported as seasonally flooded or marshy areas.

Respondents reported 23% of herbaceous species and 11% of woody species as common in the study location (Fig. 3). Abundant herbaceous species in terms of population included *Striga hermotheca*, *Sida cordifolia*, *Walteria indica*, and *Cerathoteca sesamoides.* The first three species are invasive weeds (Hiernaux and Ayantunde 2004) which are difficult to eradicate once they are established. Abundance of these species is an indication of poor soil fertility or degraded land (Hiernaux and Ayantunde 2004). *Cerathoteca sesamoides* is highly sought after as a vegetable for human consumption and as palatable forage for animals. Among the abundant woody species mentioned by the respondents were *Piliostigma africana*, *Guiera senegalensis*, and *Acacia albida*. A significant proportion of the herbaceous and woody species was reported to be rare in the study location. Nine herbaceous species including *Cassia tora*, *Indigofera strobilifera*, *Polycarpea linearifolia*, *and Eragrostis pilosa* and one woody species *Vitellaria paradoxa* were reported to have almost disappeared in the study zone.

Sixty-five percent of herbaceous species and 77% of woody species were reported to have decreased in

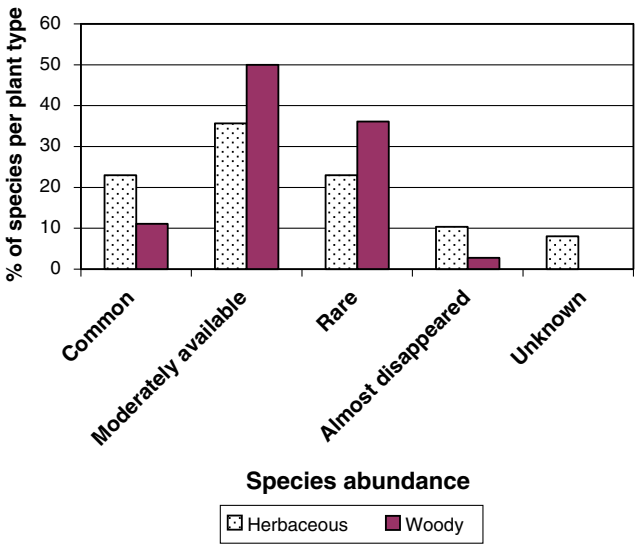

Fig. 3 Abundance of herbaceous (n=87) and woody (n=36) species in the study site according to the respondents' perception

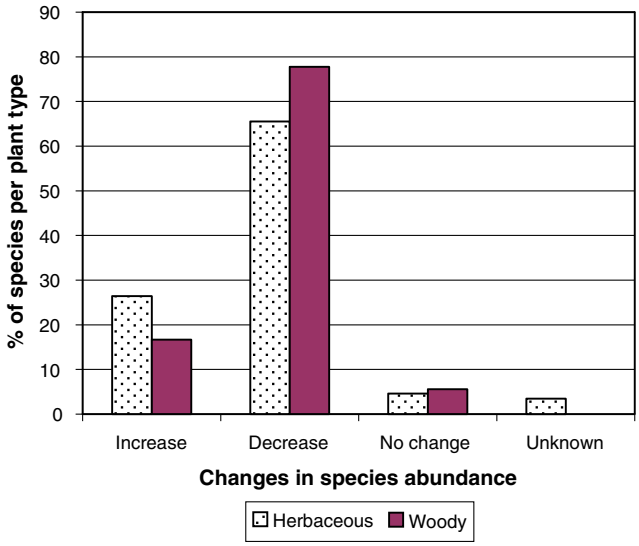

Fig. 4 Changes in herbaceous (n=87) and woody (n=36) species abundance compared to 10 years ago in the study site according to respondents' perception

abundance compared to a decade ago (Fig. 4). We need to emphasize that these results are based on respondents' perceptions and there was no monitoring of species abundance. We could not find data from long-term vegetation surveys in the study site or region to confirm or refute these local perceptions. Major reasons given for decline in abundance of these species included expansion of crop fields into rangelands, rainfall variability, decline in soil fertility, selective harvesting of certain herbaceous species for sale in peri-urban markets, and over-exploitation of certain woody species. There were few herbaceous and woody species that have increased according to the respondents. For herbaceous species, these are mainly invasive weeds such as *Striga hermotheca*, *Sida cordifolia* and *Walteria indica* or species of low nutritional value such as *Mitracarpus scaber*, *Jacquemontia tamnifolia*, and *Aristida sieberiana.* These results suggest a trend of increase in abundance of herbaceous species of little or no use as forage for livestock, and this may have serious implications for livestock production in the region if it continues.

Conclusion: Implications of Indigenous Knowledge for Natural Resource Management and Conservation

Our results illustrate uneven distribution of indigenous knowledge within the study area due to social factors such as age, gender and ethnicity. The significant effect of age on botanical knowledge confirms our hypothesis that indigenous knowledge is positively correlated with age. These results will most likely be valid for other rural communities in the West African Sahel as indigenous knowledge tends to accumulate with continued interactions with the local environment. However, different results may be observed in communities with a significant number of recent immigrants from a different ecological zone, especially as regards knowledge of forage and medicinal species, which often vary markedly with agroecological zones (Cunningham 1993; Morrison *et al.* 1996). The curvilinear trend of the relationship between age of the respondents and number of plant species identified as found in our study implies that botanical knowledge should be transmitted to younger generations before the older generation retires from pastoral and agricultural activities.

The differentiation of botanical knowledge along gender lines reinforces the need for gender awareness in development and policy interventions regarding natural resource management and conservation. Men cannot voice the knowledge of women, and neither men nor women alone can fully represent the knowledge of their community. Together, men and women form a knowledge system specific to local conditions and priorities (Grenier 1998). Another implication of our results on the effects of gender on botanical knowledge is the need to disaggregate ecological information to highlight any differences between men's and women's knowledge to avoid undue generalization which may lead to wrong conclusions. This is particularly important for natural resource management in the West African Sahel where men's and women's roles, needs, and access to and control over resources are markedly different. Inclusion of men's and women's knowledge in design and implementation of natural resource management and conservation projects will ensure that more rural people benefit from development interventions.

Results from our study also show that the individual knowledge level of woody plant species is higher than for herbaceous species due to the multiple uses of trees. This implies that conclusions based on indigenous knowledge of trees cannot be applied to all plants. In addition, these results reveal the challenge of promoting knowledge of herbaceous species, which seems to be average in our study site, in view of the heavy reliance of livestock production on natural pastures and the importance of the livestock sector in rural and national economies of the West African Sahel. Our results also show that conservation measures of plant species with multiple uses stand a better chance of succeeding than measures that only seek to protect species that are not commonly used by the communities. They also reinforce the argument that intrinsic (cultural, aesthetic, religious and ethical) and utilitarian benefits (direct use) of natural resources are of greater importance to local communities than the future unknown benefits in terms of biodiversity conservation (Swift *et al.* 2004; Holt 2005). Given the generally good knowledge level of tree species due to their multiple uses, conservation measures addressing woody plants will stand a better chance of succeeding in the region than those for herbaceous species.

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