Eliciting Local Values of Wild Edible Plants in Southern Bénin to Identify Priority Species for Conservation[1]

Estimation de la Valeur des Plantes de Cueillette Comestibles au Sud du Bénin et Définition des Espèces Prioritaires pour la Conservation

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Eliciting Local Values of Wild Edible Plants in Southern Bénin to Identify Priority Species for Conservation. When financial resources are limited, prioritization of species for conservation becomes essential. Elicitation of local perceptions of threats can be a useful means of prioritizing species and can help strengthen local conservation actions for important plant species. In the neighborhood of Dan forest (southern Bénin), we used quantitative ethnobotany tools to explore: a) how local communities value wild resources, b) if concerns of resource depletion can engender pro-active management to conserve plants and, if so, c) which criteria local people would use to select species deserving conservation. Ethnobotanical knowledge was collected using a range of different techniques. Results indicate that the villagers eat 41 wild plant species belonging to 17 families with the most important being *Parkia biglobosa*, *Vitex doniana, Vitellaria paradoxa*, *Launaea taraxacifolia,* and *Prosopis africana*. Local criteria against which value is evaluated include: i) the market importance, ii) the nutritive value, iii) the number of complementary uses of species, and iv) the availability of the resource. Additional criteria are species specific and include: v) rapid growth and production, vi) resistance to drought and diseases, and vii) life form. Although there is a real appreciation of threats, there is little evidence of pro-active conservation management by harvesters. The needs for further investigations to promote conservation of wild edible plants through use were explored.

Estimation de la Valeur des Plantes de Cueillette Comestibles au Sud du Bénin et Définition des Espèces Prioritaires pour la Conservation. En situation de ressources financières limitées, la priorisation des espèces pour la conservation devient cruciale. Pour ce faire, connaitre la perception des communautés locales par rapport aux menaces peut être un moyen utile pour renforcer les actions de conservation. Dans la zone riveraine de la Forêt de Dan (Sud Bénin), nous avons exploré: a) comment les communautés locales valorisent les plantes de cueillette, b) si la prise de conscience du déclin des ressources induit des prises d'initiatives pour conserver les plantes; le cas échéant, c) quels sont les critères de choix des espèces prioritaires. Différentes approches sont utilisées pour collecter et analyser les informations ethnobotaniques. Nos résultats indiquent que 41 espèces végétales appartenant à 17 familles sont consommées par la communauté, les plus importantes étant *Parkia biglobosa*, *Vitex doniana,*

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Vitellaria paradoxa, *Launaea taraxacifolia* et *Prosopis africana*. Les principaux critères utilisés par la communauté pour évaluer les espèces sont: i) la valeur marchande, ii) la valeur nutritive, iii) le nombre d'usages complémentaires et iv) la disponibilité de la ressource. Des critères additionnels comme la précocité, la résistance à la sécheresse et aux maladies et la forme de vie sont aussi listés. Cependant, malgré l'appréciation des menaces sur les espèces, il y a très peu d'initiatives de conservation de la part des collecteurs. Au vu de ces résultats nous avons exploré les besoins de recherche pour une conservation durable des plantes alimentaires de cueillette.

Key Words: Bénin, conservation, indigenous knowledge, selection criteria, wild edible plants.

Introduction

Wild-harvested plants remain an important source of food and income for many rural and urban households in Bénin (Avocèvou-Ayisso et al. 2009; Schreckenberg 1999). Wild resources reduce the vulnerability of communities to food insecurity and become invaluable in times of hardship (Belem et al. 2009; Misra et al. 2008; Shackleton and Shackleton 2004). For instance, within the past decade works on the consumption of traditional vegetables in several countries in Africa revealed the heavy dependency of communities on wild plants (Maundu et al. 2009). However, this dependency also results in extreme harvesting pressure that, coupled with population growth, leads to depletion of plant resources and the erosion of associated local knowledge (Davis and Wagner 2003; Kalinganire et al. 2008). The promotion of sustainable use of wild plants for improved livelihoods has been proposed on several occasions and great hopes have been placed in strategies that promote conservation through use. Advocacy for sustainable extraction of wild plant resources is nowadays an integral part of most development and conservation action plans in tropical Africa.

Biodiversity conservation usually operates at three levels: On-farm agrobiodiversity, within the wider landscape, and in protected areas (Pretty and Smith 2003). Although some attention has been given to agrobiodiversity and protected areas, the conservation of plant resources in the wider landscape has been overlooked. Conservation of local plant resources through sustainable use remains the most widely proposed means of preserving resources for future generations. Moreover, there is a growing recognition that the value (both market and non-market) that local communities place in a resource can provide an incentive for engagement in sustainable management (Brehm et al. 2010; Campbell et al. 1997). We know that people in a given community do not use and value all plant species equally. However, there is insufficient knowledge of the factors that determine the value of species in traditional communities and the socio-economic factors influencing the extent to which people depend on forest resources (Lawrence et al. 2005; Vodouhê et al. 2009). In a situation where commercial value is not appropriate, we need a quantitative method to determine the relative value a community ascribes to a specific resource. To this end, Prance et al. (1987) proposed two classes of resource—major and minor—based on the extent to which communities use them. However, when conservation resources are limited, a finer resolution and prioritization become essential. Over the last three decades, several methods were developed for defining priority species; however, almost all of them were based on rarity and/or endemicity parameters (Brehm et al. 2010). How to express values in ways that explicitly reflect the significance of the plants as perceived by local dwellers (Lawrence et al. 2005) is a central question to this study.

Here, we highlight the case of the Dan forest in the neighborhood of Agbohoutohoue village in the Djidja district, where over-exploitation of tree resources for fuelwood and charcoal has been noted for several decades. We investigated and reflected on approaches that can be used to mitigate drastic land transformation and overuse of local resources in this area. The study aims to: 1) understand how local communities value wild edible plants, 2) assess the perception of the Agbohoutohoue community towards sustainable management of wild edible plants, and 3) reveal criteria local people would use to select species deserving conservation actions. A greater understanding of these issues could help develop community-based conservation programs at least for priority species.

Materials and Methods

Study Area

The study was carried out in the neighborhood of the Dan forest in the Fon community of Agbohoutohoue, Djidja District (Fig. 1). The

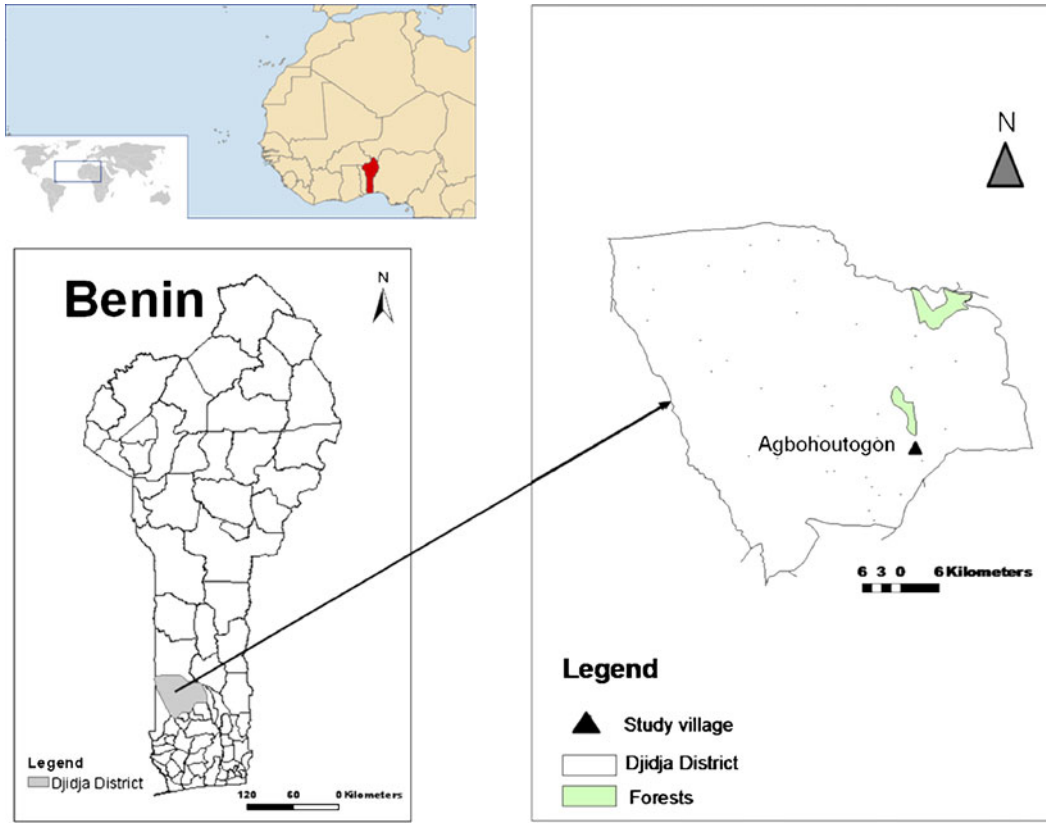

Fig. 1. Study area: Agbohoutogon in South Bénin.

Fon community is one of the major sociolinguistic groups in Bénin (Floquet and van der Akker 2000) and is the dominant ethnic group in the Dan area. The Agbohoutohoue community was chosen because of its proximity to the Dan forest to provide a case study in which a significant forest resource is under local control. In addition, the village has low infrastructural and economic development and the use of wild foods in the community is still important.

The study area is located on a flat land of 200 to 300 m altitude in the Sudano-Guinean transition zone. The annual rainfall varies from 900 to 1200 mm with two rainy seasons (March to July and September to October). Soils are predominantly hydromorphic or sandy-clay. The natural vegetation is made up of savanna woodland, fallows, and a mosaic of secondary and gallery forests including the Dan forest. This landscape provides a range of forest resources from which many edible wild plants are collected. Despite a high degree of dependency on these resources, the natural vegetation is being depleted through clearance for agriculture and tree plantations, logging for charcoal production, and grazing. The Dan forest is itself in the process of transformation into crop fields and plantations.

The population density is one of the highest in Bénin, with up to 552 people per km^2 (seven times the national average) in the Plateau of Abomey to which our study village belongs (DED-INSAE 2005). Agbohoutohoue is recognized as a big producer of cultivated vegetables such as African eggplant (*Solanum macrocarpon* L.), silver cockscomb (*Celosia argentea* L.), and chili pepper (*Capsicum frutescens* L.), which represent an important source of income for many households.

Approach

In Agbohoutohoue, we conducted semi-structured interviews (SSI), focus group discussions

(FGD), and field walks to facilitate plant collection. Participants to the survey were selected by combining purposive and snowball sampling techniques. The village chief was the starting point for the semi-structured interviews, and at the end of each interview the respondent was asked to name other key informants he or she knows. A total of 15 households were selected with this method. The respondents were male heads of households and the eldest or leading woman; in total 30 semi-structured interviews were completed. Three focus group discussions were carried out with key informants identified by their peers from the SSIs (men and women equally represented, 60 years old on average). Two resource people were consensually selected among the participants to assist with plant collection during the forest walks.

Diversity and Use Patterns of Wild Food Plants

An introductory focus group discussion (FGD1) of 20 people was organized (without age limitation), with the objective of a) generating a complete community list of wild food plants and harvesting sites and b) preparing an outline resource map of the village. Using the village resource map, two forest walks were organized to collect vouchers of species listed by participants in FGD1. During the forest walks we collected information on species habitat, the management status of those habitats, harvesting practices, informants' perception of abundance/rarity of the plants, seasonality, frequency of use during abundance periods, and substitute species during shortage periods. Voucher specimens helped resolve multiple naming problems, which are expected when dealing with folk taxonomy (Achigan-Dako et al. 2010). Voucher specimens were deposited at the National Herbarium of Bénin, University of Abomey-Calavi.

Elicitation of Value Criteria, Perception of Risks, and Definition of Priority Species

Role plays (Campbell et al. 1997) were used to elicit local values for wild food resources. They were implemented during a series of focus group discussions to reveal participants' perception of threats to species using the ranking method and their definition of priority species to conservation using the scoring method. The overall value of a species can be conceptualized as comprising an amalgam of values for largely independent criteria. However, when comparing species for their importance in ethnobotanical studies, the elicited values are seldom disaggregated. We used the scoring method of Wong et al. (2002a, b) to elicit the components of resource value (which we term criteria), and to identify valuable and priority species. The ranking approach is recommended for cases with relatively few items and is easier when the objects can be handled (Wong et al. 2002b).

The exercises consisted in trading-off a given species for another one (choice experiment) with the decision based on relative values assessed against criteria decided by the group. The steps used to elicit criteria were as follows: First we took samples of two species and asked participants to choose the most valuable or important to them. After they had chosen one, they were asked what it was about that species that made it more valuable than the other, for example, they may have responded "it is tastier." Such statements suggest that organoleptic traits can be used as the basis for value judgments and became the criteria against which values for a range of species could be valued. This exercise was repeated to elicit a range of criteria that can be used to distinguish between plants. The list of criteria was presented to the group for review and confirmation.

Group discussions 2 and 3 used a sample of 10 experts (men and women equally represented) selected by their peers of FGD1 and they constantly participated in all the rest of research activities. The FGD2 used the list of elicited criteria to record values of a range of species. Using a simple question-and-answer system, each group participant was asked to name and score each species from 1 (lowest) to 4 (highest) against each value criterion. To compare results of the ranking and the scoring approaches, the top 12 species from the scoring were pair-wise ranked by the same FGD2.

In the third group discussion (FGD3), the participants were asked to reflect on their perception of risks to harvested species in connection with the following question: a) threats to species, b) criteria for selecting species for pro-active management, c) listing of current management practices, d) conservation actions they would suggest, and e) list of species that they perceive as fast declining and for which they see a need for conservation. These points were first elicited in SSIs.

In FGD3, the following exercises were used to explore the causes and severity of perceived

species decline: i) a pair-wise ranking of the listed species, ii) a problem-tree based discussion of the reasons of species decline and impact analysis, and iii) an open discussion of the need for conservation and possible actions at the community level.

Data Analysis

A range of descriptive statistics for species diversity and use patterns were derived from the collated data. The specific community value of a given species *j* (SCV_j) was computed, following Philips and Gentry (1993) and Fandohan et al. (2010) as:

$$scv_j = \sum_{i}^{n} S_{ij},$$

with S_{ij} being the score given to the species *j* by the community, in relation to the specific value criterion *i*, and *n* the number of value criteria used by the community to score and then rank species. The prioritization was based on the premise that species with higher *SCV* values are worthier than those with lower *SCV* values. We used the Spearman's rank-order correlation (rho) statistic to examine correlations between value criteria.

The Spearman's non-parametric correlation coefficient was used to analyze the similarity of the result derived from the scoring to that of the pair-wise ranking. We used the Mann-Whitney's test (U) to determine whether the perception of threats or value is gender related.

Results

Species Richness and Use Patterns in the Community

The group discussions revealed 41 wild edible species belonging to 27 plant families (list available from authors). Species are harvested from vegetation types such as farms, fallows, nearby village, savannas, and forests. They are mostly collected from fallows (80.5%) and farms (51.2%), though several of them (e.g., *Ceratotheca sesamoides* Endl. and *Launaea taraxacifolia* [Willd.] Amin ex.Jeffrey) occur in more than one habitat.

Many species are multi-purpose plants, with edible leaves, fruits, and/or seeds (e.g., *Parkia biglobosa* (Jacq.) G. Don, *Vitex doniana* Sweet, *Vitellaria paradoxa* C.F. Gaertn., and *Prosopis africana* (Guill. & Perr.) Taub). More than 50% of tree species belong to this category. About 70.7% of listed species, mostly herbaceous plants, are consumed as vegetables (Table 1). Another 36.6% of the species provide raw fruits. Herbs represent 39% of the wild food plants.

Consumption of many species is seasonal. About 24.4% (10 species) are available throughout the year, 34.1% in the rainy seasons, with the remaining 41.5% only available in dry seasons. We also found that 41.5% of species are "often" or "frequently" consumed whereas 58.5% are "occasionally" or "rarely" eaten, even though they might be abundantly available.

Local Value of Edible Wild Plants and Definition of Priority Species for Active Management

Four main criteria were used by villagers to determine the value of wild edible plants: i) the market value, ii) the nutritive value, iii) the number of other uses, and iv) the availability of the resource. According to informants, the nutritive importance of a species is defined by its popularity, the absence

Table 1. Species counts and percentages (in brackets) of use types per life form; species usually have more than one use.

	Species count	Uses			
		Vegetables	Fruits	Medicinal	Other uses
Life form					
Herbaceous	16	15 (93.8%)	1(6.3%)	5 (31.3%)	1 (6.3%)
Liana/vine	6	2 (33.3%)	3 (50%)	2 (33.3%)	4 (66.7%)
Shrub	7	4 (57.1%)	4 (57.1%)	4 (57.1%)	2 (28.6%)
Tree	12	8 (66.7%)	7 (58.3%)	9 (75%)	10 (83.3%)
Counts by use type	41	29 (70.7%)	15 (36.6%)	20 (48.8%)	17 (41.5%)

TABLE 2. SCORING MATRIX FOR SPECIES VALUE ESTIMATION.

Scientific name	Nutritive importance	Number of uses	Market importance	Energy input	Additional cost	Availability	$\sum S_{ij}$	Rank
Parkia biglobosa (Jacq.) G.Don	4	4	4	1	4	3	20	1
Vitex doniana Sweet	4	3	4	2	2	2	17	2
Vitellaria paradoxa C.F.Gaertn.	2	4	3	2	3	3	17	2
Launaea taraxacifolia (Willd.) Amin ex.Jeffrey	3	3	3	2	2	3	16	4
Prosopis africana (Guill. & Perr.) Taub.	1	3	3	3	4	2	16	4
Corchorus tridens L.	3	2	1	3	3	3	15	6
Deinbollia pinnata (Poir.) Schumach. & Thonn.	2	2	1	4	3	3	15	6
Adansonia digitata L.	2	3	2	3	3	1	14	8
Cleome ginandra L.	1	2	1	3	3	4	14	8
Hibiscus asper Hook.f.	2	3	2	3	3	1	14	8
Blighia sapida K.D.Koenig	2	2	2	3	3	2	14	8
Pericopsis laxiflora (Baker) Meeuwen	2	3	1	2	3	3	14	8
Amaranthus viridis L.	3	1	2	3	2	2	13	13
Cissus populnea Guill. & Perr.	1	3	1	3	3	2	13	13
Ocimum gratissimum L.	2	3	2	2	2	2	13	13
Crassocephalum rubens (Juss. ex Jacq.) S.Moore	3	2	3	1	1	3	13	13
Paullinia pinnata L.	1	2	1	3	3	3	13	13
Amaranthus spinosus L.	1	1	1	3	3	4	13	13
Crotalaria macrocalyx Benth.	1	2	1	2	3	4	13	13
Spondias mombin L.	2	2	1	3	3	1	12	20
Stachytarpheta indica (L.) Vahl	2	2	2	1	3	2	12	20
Dioscorea bulbifera L.	2	1	1	3	3	2	12	20
Dioscorea preussii Pax	2	1	1	3	3	2	12	20
Vernonia colorata (Willd.) Drake	2	2	2	2	1	3	12	20
Grewia mollis Juss.	1	1	1	3	3	3	12	20
Commelina diffusa Burm.f.	1	2	1	2	2	4	12	20
Newbouldia laevis (P.Beauv.) Seem.	1	2	1	3	3	1	11	27
Ceratotheca sesamoides Endl.	2	1	1	3	2	2	11	27

(Continued)

TABLE 2. (CONTINUED).

Scientific name	Nutritive importance	Number of uses	Market importance	Energy input	Additional cost	Availability	$\sum S_{ij}$	Rank
Momordica charantia L.	1	2	2	2	1	3	11	27
Talinum triangulare (Jacq.) Willd.	1	1	1	2	3	3	11	27
Ficus sur Forssk.	1	1	1	3	2	3	11	27
Flacourtia flavescens Willd.	1	1	1	3	3	1	10	32
Annona senegalensis Pers.	1	2	1	2	2	2	10	32
Icacina trichantha Oliv.	2	2	2	1	1	2	10	32
Uvaria chamae P.Beauv.	1	2	1	2	2	2	10	32
Lippia multiflora Moldenke	1	2	1	2	2	2	10	32
Daniellia oliveri (Rolfe) Hutch. & Dalziel	1	1	1	2	2	3	10	32
Aframomum cereum (Hook.f.) K.Schum.	1	1	1	3	2	1	9	38
Struchium sparganophorum (L.) Kuntze	1	1	1	2	2	2	9	38
Senna occidentalis (L.) Link	1	2	1	1	1	3	9	38
Macrosphyra longistyla (DC.) Hiern	1	1	1	1	1	3	8	41

of taboos, and the health benefit procured. In addition, the energy input for processing (e.g., for cooking) and the amount of additional input needed (i.e., additional cost) were also considered as criteria. Although considered of least importance by respondents, these two criteria were included in the overall species scoring as they may influence the frequency of use. The scoring exercises revealed that the top five species were *Parkia biglobosa, Vitex doniana, Vitellaria paradoxa, Launaea taraxacifolia,* and *Prosopis africana*. These species have high market value, multi-uses, and are perceived as highly nutritive (Table 2). The next five species, *Corchorus tridens* L.*, Deinbollia pinnata* (Poir.) Schumach. & Thonn.*, Adansonia digitata* L.*, Cleome gynandra* L., and *Hibiscus asper* Hook.f., are species that are easy to process, require little additional inputs but can bring in no or little cash to households.

The relationships among the elicited value criteria were examined using Spearman's correlation coefficient (Table 3). Market importance showed significant positive correlation with nutritive importance (rho = 0.631; $p < 0.01$) and also the number of complementary uses (rho = 0.601; $p < 0.01$). The nutritive value showed a significant positive, albeit weak (rho = 0.384), correlation with the number of complementary uses ($p < 0.05$). The energy input required and the cost of ingredients or time needed to process a species are correlated (rho = 0.509; $p < 0.01$). Availability of a species does not show a significant correlation with any of the other criteria.

To check whether the scoring and ranking methods lead to the same conclusions, we pair-wise ranked the 12 most important species from the scoring (Table 4). The Spearman's non-parametric rank-order test showed a significant positive and strong correlation between the order of the 12 species derived from the scoring and pair-wise ranking (rho = 0.951, $p < 0.001$). We therefore conclude that *Parkia biglobosa*, *Vitex doniana, Vitellaria paradoxa*, *Launaea taraxacifolia*, and *Prosopis africana* are the five most valued edible species in the neighborhood of Dan forest.

From the SSIs, several criteria guide the choice of species that deserve active management according to villagers. These criteria include the nutritive importance of the species, its market value, and the number of utilizations associated

TABLE 3. CORRELATION MATRIX OF THE SIX CRITERIA USED BY VILLAGERS TO JUDGE THE VALUE OF WILD EDIBLE PLANTS (* $P<0.05$; ** $P<0.01$; NS=NOT SIGNIFICANT).

	Nutritive importance	Number of uses	Market importance	Energy input	Additional cost	Availability
Nutritive importance	1					
Number of uses	0.384*	1				
Market importance	0.631**	0.601**	1			
Energy input	−0.077 ns	−0.219 ns	−0.322*	1		
Additional cost	0.057 ns	0.225 ns	−0.051 ns	0.509**	1	
Availability	−0.132 ns	−0.030 ns	−0.096 ns	−0.279 ns	−0.084 ns	1

TABLE 4. PAIR-WISE RANKING MATRIX OF MOST IMPORTANT SPECIES FOR CONSERVATION ACTIONS.

Species	P.b	V.d	V.p	L.t	P.a	D.p	C.t	C.g	P.l	B.s	A.d	H.a	Total scores	Pair-wise rank	Scoring rank
P. biglobosa (P.b)		P.b	P.b	P.b	P.b	P.b	P.b	P.b	P.b	P.b	P.b	P.b	11	1	1
V. doniana (V.d)			V.d	V.d	V.d	V.d	V.d	V.d	V.d	V.d	V.d	V.d	10	2	2
V. paradoxa (V.p)				V.p	P.a	V.p	V.p	V.p	V.p	V.p	V.p	V.p	8	3	2
L. taraxacifolia (L.t)					L.t	L.t	L.t	L.t	L.t	L.t	L.t	L.t	8	3	4
P. africana (P.a)						P.a	P.a	P.a	P.a	P.a	P.a	P.a	8	3	4
D. pinnata (D.p)							C.t	D.p	D.p	D.p	D.p	D.p	5	7	6
*C. tridens (*C.t*)*								C.t	C.t	C.t	C.t	C.t	6	6	6
C. gynandra (C.g)									C.s	B.s	A.d	H.a	0	12	8
P. laxiflora (P.l)										C.s	C.s	C.s	4	8	8
B. sapida (B.s)											A.d	H.a	1	11	8
A. digitata (A.d)												A.d	3	9	8
H. asper (H.a)													2	10	8

Initials in cells show which of the two species being compared is most important.

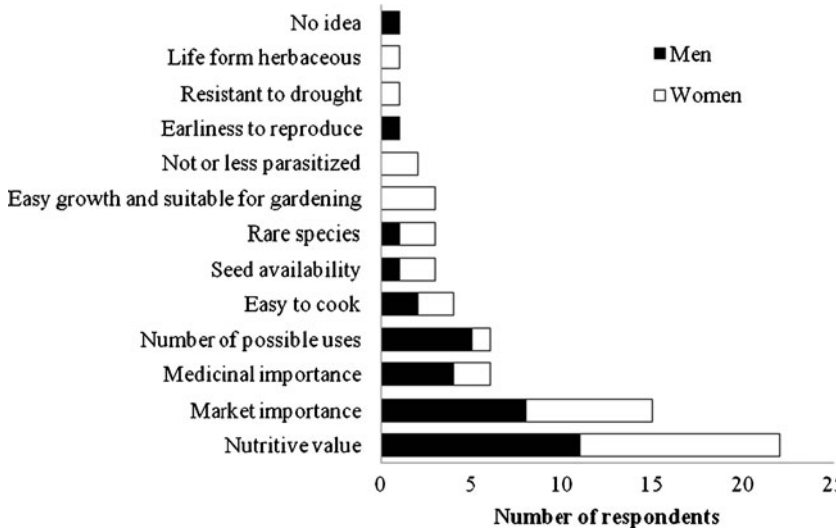

Fig. 2. Criteria (by respondent count) used by male and female community members in Agbohoutohoue to select species for conservation actions.

with it (Fig. 2). About 73% of respondents indicated the nutritive importance as the main reason for selecting a species for active management; market importance ranks second (50% of respondents). Other criteria include medicinal value and complementary uses, cooking or processing ability, and availability. Active management of species by villagers implies cultivation, as the natural vegetation is disappearing at a high rate. Thus, villagers consider that other specific criteria such as suitability for gardening, rapid growth and production, resistance to pests, disease, and drought are desirable. The gender difference in this perception is not significant ($p=0.40$).

Based on the results of species value and priority criteria, the perceived need for conservation of each species is presented (Table 5).

Community's Perception of Risks to Harvested Species

Assessment of the perception of risk to harvested species indicated that 90% of respondents were aware that overexploitation will result in the demise of the species. There were slightly more women (93%) than men (87%) who acknowledged this relationship and around 10% of respondents believe that plant species cannot disappear. Instead they argued that plants respond to pressures imposed by humans and nature by changing into other forms ("ecotypes"). Moreover, harvesters seek substitutes when a plant becomes scarce and so are not concerned with the loss of an individual species.

Informants listed 20 wild edible plant species that they perceived as fast declining in the local landscape (Fig. 3). For instance, 76.6% of respondents (gender mixed) reported the decline of populations of *Vitex doniana* and gave it high priority for conservation. A few species such as *Corchorus tridens, Ceratotheca sesamoides, Cleome gynandra,* and *Prosopis africana* were perceived as declining by only one gender although the Mann-Whitney test for two independent samples indicated that the gender difference was not significant ($p=0.346$).

Results of the ranking indicated that the most threatened species include *Vitex doniana*, *Crassocephalum rubens*, *Prosopis africana*, *Ceratotheca sesamoides*, and *Ocimum gratissimum* (Table 6).

Analysis of Threats and Management of Species

To further understand the extent of conservation concerns of villagers, we assessed individual actions designed to conserve threatened species. We found that most villagers do little to address perceived risks. Only 13.3% of the farmers (both genders) spare resources during land clearance (Fig. 4), while 6.7% spread seeds

TABLE 5. SPECIES AND DEGREE OF CONSERVATION NEED.

Group	Species	Ranks for aggregated scores	Characteristics	Conservation need
1	*Parkia biglobosa, Vitex doniana, Vitellaria paradoxa, Launaea taraxacifolia* and *Prosopis africana*	Top 5	High market and nutritive value, with many complementary uses.	High
2	*Corchorus tridens, Deinbollia pinnata, Pericopsis laxiflora, Blighia sapida, Cleome gynandra, Adansonia digitata* and *Hibiscus asper*	6th to 12th	Low market and nutritive value with some complementary uses.	|
3	*Amaranthus viridis, Crassocephalum rubens, Amaranthus spinosus, Cissus populnea, Crotalaria macrocalyx, Paullinia pinnata* and *Ocimum gratissimum*	13th to 19th	Low market and nutritive value, with limited complementary uses. Relatively low energy input.	|
4	*Stachytarpheta indica, Commelina diffusa, Vernonia colorata, Spondias mombin, Dioscorea bulbifera, Dioscorea preussii, Grewia mollis, Momordica charantia, Uvaria chamea, Icacina trichantha, Annona senegalensis, Aframomum cereum, Ceratotheca sesamoides, Ficus sur, Newbouldia laevis, Talinum triangulare, Flacourtia flavescens, Macrosphyra longistyla, Struchium sparganophorum, Senna occidentalis, Lippia multiflora* and *Daniellia oliveri*	20th to 41st	Very low market and nutritive value, with very limited complementary uses. High-energy input and high additional cost.	| Low

of wild edible species in their farms as shown in Fig. 5.

Villagers were aware of the causes of species decline. They listed the increase in human population, the increasing logging for charcoal and timber, the heavy harvesting of plants (especially bark, roots, and stems) for medicinal use, overgrazing, bush fires, all of which they perceive as leading to soil erosion, drought, and hunger. According to farmers, the pressure on useful species is illustrated by the steady replacement of *Prosopis africana* and *Anogeissus leiocarpa* (DC.) Guill. & Perr., two charcoal species until recently abundant in the landscape, by *Parkia biglobosa* and *Vitellaria paradoxa* primarily used as food trees. Use of destructive harvesting practices, for instance the felling of trees to collect young edible leaves (e.g., *Vitex doniana*), was also mentioned by respondents.

Discussion

SELECTION OF PRIORITY SPECIES AND IMPLICATIONS FOR CONSERVATION

Our study indicated that there is a relatively wide range of wild plant species from which edible products are collected by the community of Agbohoutohoue. Species are harvested from various habitats and our results are in accord with Schreckenberg's (1999) observation

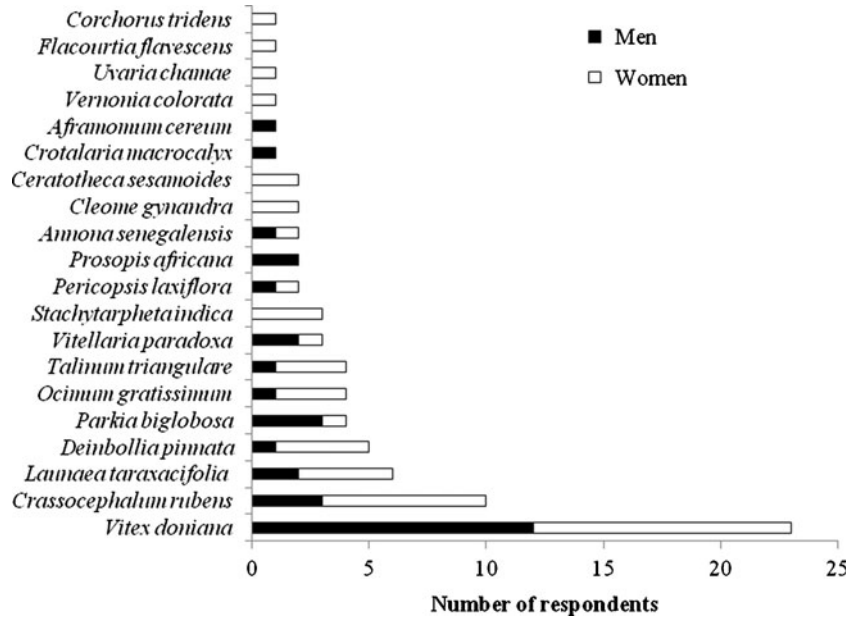

Fig. 3. Frequency of species (by respondent count) perceived as rapidly declining in the environment by male and female community members in Agbohoutohoue.

that fallows and fields are the most important sources of commonly marketed non-timber forest products (NTFPs) in the Guinea savannah ecozone.

We also found that communities value and select their wild edible resources using a combination of criteria, not just market value. In addition to economic criteria, villagers use sociocultural and environmental criteria to determine species value. This supports the assertion by Campbell et al. (1997) that the valuation of a select range of natural products based on the sole market price is misleading. Some of the valuation criteria are correlated indicating the strong links between them. This also was reported by Kristensen and Lykke (2003) in a similar survey in 10 villages in Burkina-Faso. However, other criteria were not correlated (e.g., market importance and availability), which calls for caution in generalization. Successful management strategies will then need to consider the criteria that communities use in their species valuation, because strategies that operate exclusively with market-based or conservation-based criteria are likely to overlook communities' interest. Based on elicited criteria, *Parkia biglobosa, Vitellaria paradoxa*, and *Vitex doniana* were shown to be the three most important species by villagers of Agbohoutohoue. These species also were ranked respectively as first, second, and fifth conservation priority species, in south-central Burkina-Faso (Kristensen and Lykke 2003). Furthermore, Schreckenberg (1999) identified *Vitellaria paradoxa* and *Parkia biglobosa* as the most vital species for people's livelihoods in Bassila (northern Bénin), confirming the national significance of these species.

Rarity is not the main driver for conservation by villagers; the perceived value of a species influences the choice for active management, and this needs to be considered by conservation agents for successful management strategies. The casual use of some abundant species in the study area and the pressure on other rare species (e.g., *Vitex doniana*) illustrate that species are not valued in the same ways. *Parkia biglobosa, Vitellaria paradoxa*, and *Launaea taraxacifolia* are not rare in the study area but count as priority species to villagers. As suggested by Vodouhê et al. (2010), understanding and considering the complex interplay of local criteria for valuation and perception of threats could greatly increase the acceptability and success of conservation actions at the local

TABLE 6. PAIR-WISE RANKING MATRIX OF MOST THREATENED SPECIES REQUIRING CONSERVATION ACTIONS.

Species	V.d	C.r	L.t	D.p	V.p	T.t	O.g	P.b	S.i	P.a	P.l	C.g	C.se	A.s	Total	Rank
Vitex doniana (V.d)		V.d	V.d	V.d	V.d	V.d	V.d	V.d	V.d	V.d	V.d	V.d	V.d	V.d	13	1
Crassocephalum rubens (C.r)			C.r	C.r	C.r	C.r	C.r	C.r	C.r	C.r	C.r	C.r	C.se	C.r	11	2
Launea taraxacifolia (L.t)				L.t	L.t	T.t	O.g	L.t	S.i	P.a	L.t	L.t	C.se	L.t	6	7
Deinbollia pinnata (D.p)					D.p	T.t	O.g	D.p	S.i	P.a	P.l	C.g	C.se	D.p	3	11
Vitellaria paradoxa (V.p)						T.t	O.g	P.b	S.i	P.a	P.l	C.g	C.se	A.s	0	14
Talinum triangulare (T.t)							O.g	T.t	T.t	P.a	P.l	C.g	C.se	T.t	6	7
Ocimum gratissimum (O.g)								O.g	O.g	P.a	O.g	O.g	C.se	O.g	9	5
Parkia biglobosa (P.b)									S.i	P.a	P.l	P.b	C.se	P.b	3	11
Stachytarpheta indica (S.i)										P.a	P.l	C.g	C.se	S.i	5	9
Prosopis africana (P.a)											P.a	P.a	P.a	P.a	11	2
Pericopsis laxiflora (P.l)												P.l	C.se	P.l	7	6
Cleome gynandra (C.g)													C.se	C.g	5	9
Ceratotheca sesamoides (C.se)														C.se	11	2
Annona senegalensis (A.s)															1	13

Initials in cells show which of the species being compared is most rare.

level. Asking people to judge what qualifies species that deserve active management can provide a means for setting local priorities for the community and natural resource managers. Local people's choices of species deserving active management are likely to differ from those selected by conservation scientists and other resource managers. However, Codjia et al. (2003) suggest that priority must be given to species preferred by local communities during elaboration of management plans. This is supported by our study, which is an important step in methodological development for local valuation studies of natural resources and prioritization of species for conservation.

Methodologically, our approach differs from that used by Lawrence et al. (2005), Maraseni (2008), and Vodouhê et al. (2009) who identified the most important NTFPs in Cameroun, Nepal, and northern Bénin, respectively. The main point of difference is that we used an independent scoring of species against value and conservation criteria developed by the community. The scoring and pair-wise ranking methods produced similar results, revealing their usefulness for triangulation. However, the scoring approach to elicit plant value to communities has greater utility as it produces quantitative data to which statistical analyses can be applied. We therefore recommend the use of the scoring method for studies of this type with the proviso that it is based on thoroughly elicited criteria.

COMMUNITY PERCEPTION OF RISKS TO SPECIES AND IMPLICATIONS FOR CONSERVATION

Species vary in their edibility and they do not all have the same importance in the diet nor in the social and economic life of villagers. We hypothesized that this difference will influence the appreciation of threats to these species and hence the motivation to conserve them.

Our study revealed that communities may perceive the risks facing species through over-harvesting, and may even be able to clearly identify the causes, but this awareness may not necessarily translate into pro-active interventions by harvesters, even when the species is perceived to be of value. This perception is not gender related. Explanations of this situation include the lack of alternative resources

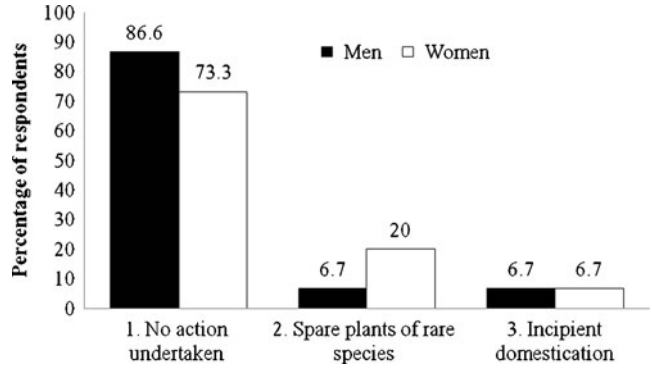

Fig. 4. Percentage of respondents for conservation actions initiated by male and female community members in Agbohoutohoue.

and the lack of community decision-making structures to coordinate actions. In addition, Fig. 2 revealed that most of the agronomic criteria (e.g., easy growth and suitability for gardening, earliness to reproduce, and resistance to drought) were less important to the community. However, some incipient management of wild species was noted. Indeed, farmers report sparing *Parkia biglobosa* during land clearing, a practice also reported by Schreckenberg (1999) and Codjia et al. (2003). Apart from sparing, domestication or cultivation of rare valuable species is an avenue to explore for sustainable utilization of resources such as *Vitex doniana* for which a case was made in Achigan-Dako et al. (2011). Domestication or cultivation by farmers as a conservation strategy is weakened by the lack of research support for the development of propagation techniques (i.e., propagation of some species is yet to be fully understood). This calls for research on regeneration and agronomic studies that could be extended to the top three species, namely *Parkia biglobosa, Vitex doniana, and Vitellaria paradoxa.* In addition, further investigations are also needed to fully understand what prevents local communities from engaging in conservation or cultivation of perceived high value resources.

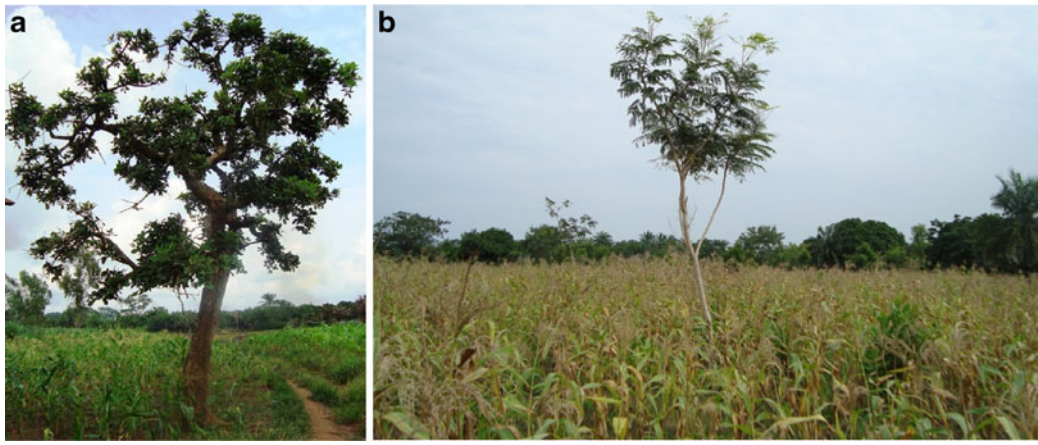

Fig. 5. Rare plants spared in crop fields: **a** *Vitex doniana* and **b** *Parkia biglobosa*.

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