Society and Natural Resources, 25:1221–1240

ISSN: 0894-1920 print/1521-0723 online
DOI: 10.1080/08941920.2012.674628

Land Use and Biodiversity in Unprotected Landscapes: The Case of Noncultivated Plant Use and Management by Rural Communities in Benin and Togo

JONNE RODENBURG

Africa Rice Center (AfricaRice), East and Southern Africa, Dar es Salaam, Tanzania

JUDITH BOTH

Resource Ecology Group/Environmental Policy Group, Wageningen University, Wageningen, The Netherlands

IGNAS M.A. HEITKÖNIG

Resource Ecology Group, Wageningen University, Wageningen, The Netherlands

C.S.A. (KRIS) VAN KOPPEN

Environmental Policy Group, Wageningen University, Wageningen, The Netherlands

BRICE SINSIN

Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, Cotonou, Benin

PAUL VAN MELE

Agro-Insight, Ghent, Belgium

Received 3 February 2011; accepted 28 December 2011.

This study is an output of the Inland Valley Consortium (IVC) convened by the Africa Rice Center (AfricaRice). Financial assistance to this study was granted by the Dutch Directorate-General for International Cooperation (DGIS) through the Associate Experts Program. We thank Chabi Adeyemi of AfricaRice, Soklou Worou of ITRA (Togo), Aristide Adomou of the Université d'Abomey-Calavi, and Charles Agli of INRAB (Benin) for their kind assistance. The authors attest originality of the data and assume full responsibility for any remaining shortcomings. The ideas expressed in the article are those of the authors and do not necessarily reflect those of the donors or affiliated institutions.

Address correspondence to Jonne Rodenburg, Africa Rice Center (AfricaRice), PO Box 33581, Dar es Salaam, Tanzania. E-mail: j.rodenburg@cgiar.org

PAUL KIEPE

Africa Rice Center (AfricaRice), East and Southern Africa,
Dar es Salaam, Tanzania

To contribute to the development of strategies for sustainable agricultural land use and biodiversity conservation in landscapes without formal protection status, we investigated the local use and management of noncultivated plants as important ecosystem functions of inland valleys in south Benin and Togo, and local perceptions on changes in plant biodiversity and causes for these changes. Local users of noncultivated plants perceived agriculture and construction as major factors contributing to the reduction of (noncultivated) plant biodiversity. However, they also collect many useful species from agricultural fields and the village. A small community forest reserve and a 2-ha community garden were the only organized forms of conservation management. Observed ad hoc conservation initiatives were selective harvesting of plant parts, preserving trees during land clearing, and allowing useful weed species in the field. Future development and conservation efforts in unprotected landscapes with multiple ecosystem functions should acknowledge knowledge, interests, and needs of local communities.

Keywords community conservation, inland valleys, landscape planning, local knowledge, natural resource management, plant biodiversity, rural areas, sustainable land use, weeds, West Africa

Balancing Ecosystem Functions for Sustainable Land Use

In Africa, rural populations largely depend on natural resources for their livelihood (e.g., Dixon and Wood 2003; Okello et al. 2009). While intensification of agricultural production is required in order to provide food and income to the growing population, rural people also extensively use noncultivated plants for their daily needs (e.g., Dansi et al. 2008; Hermans et al. 2004; Kristensen and Lykke 2003). Expansion of agricultural area almost always leads to a reduction of species diversity (Swift et al. 2004), due to the resulting habitat destruction and unsustainable land-use practices. However, Honnay et al. (2005) found that habitat fragmentation as such does not necessarily result in large-scale extinction of (forest) plant species. Moreover, nonprotected areas carry multiple levels of biodiversity worthy of conservation (e.g., Gardner et al. 2007). Scenarios combining agricultural development with sustainable resource use and biodiversity conservation are therefore feasible (e.g., Dixon and Wood 2003). Local communities inherently play a pivotal role in such scenarios. However, information on current perceptions and biodiversity management practices of African communities is scant. The significance of biodiversity conservation and threatened species is primarily investigated from a global perspective, while local (plant) biodiversity use and conservation efforts have only recently been assessed (e.g., Gardner et al. 2007). Rural people have an incentive to conserve (noncultivated) plant biodiversity if it helps them to sustain or improve their livelihood (Etkin 2002). Hence, for balancing biodiversity conservation and land use, insights about stakeholders' knowledge and perceptions of local species are required (Sick 2008) to understand which noncultivated plant species are important to local users and for what reasons, how they perceive species abundance and threats, and what they do to manage or preserve valuable species. The current study focuses on these aspects.

Biodiversity in Vulnerable Rural Landscapes Without Protection Status

Our study targets the upland-lowland continuum, hereafter referred to as "inland valleys," as these are common landscapes that generally constitute both high agricultural production potentials and local biodiversity hot spots lacking any formal protection status. Their multifunctional character renders these ecosystems both particularly interesting from different use perspectives, and vulnerable to degradation of natural resources, jeopardizing their unique and plural ecosystem functions (e.g., Dixon and Wood 2003). The trade-off between land use and conservation of natural resources is critical in African wetlands (e.g., McCartney and Houghton-Carr 2009), including inland valleys. As the importance of such ecosystems for local communities has often been overlooked in policy and planning (Silvius et al. 2000), there is a need to study the local use and management of ecosystem functions of the inland valleys to raise the necessary awareness of their importance (Dixon and Wood 2003) and to generate recommendations for sustainable land use. Moreover, the knowledge, values, and management activities of local rural communities, often neglected in decision making with respect to resource management and landscape planning (Dietz et al. 2003), constitute important information for the establishment of conservation policies and implementation (Pretty and Smith 2004) and social development (Casas et al. 2001). Although the role rural communities in developing countries can play in the management and conservation of natural resources, such as biodiversity, has been subject to debate (e.g., Redford and Sanderson 2000; Schwartzman et al. 2000a; Schwartzman et al. 2000b; Terborgh 2000), Del Amo-Rodríguez et al. (2010) state that involvement of local populations in planning and management of local natural resources is essential for its success. Moreover, although many studies (e.g., Wilson 1997) investigated biodiversity conservation within natural protected areas (NPAs), based on their long-term experience in Mexico, Del Amo-Rodríguez et al. (2010) also argue that it should not be restricted to NPAs alone, as conservation can also be achieved in areas occupied by local communities, through the way these people use and manage natural resources. The current study was conducted to verify broader applicability of the preceding assumptions in a common West African environment lacking formal protection status, and taking plant resources as a test case. To date, studies addressing such questions and hypotheses have been almost exclusively conducted with communities living in or near NPAs and forest reserves. Perceptions of local communities living in landscapes without formal protections status have received much less attention, while such landscapes and the communities occupying them are of increasing strategic importance in the near future. Many studies reported gender and age differences in the local knowledge, use, and preferences of plant resources in protected (forest) areas (e.g., Gómez-Baggethun et al. 2010; Vodouhe et al. 2009; Voeks 2007). Reportedly there are gender differences in the use of plant species ("gendered species") or rather plant products (e.g., timber, fire wood, fruits) and the locations ("gendered spaces") where they are collected (Howard and Nabanoga 2007; Pfeiffer and Butz 2005). Most of these gender differences can be explained by differences in household responsibilities and rights that are often observed in traditional and rural communities (e.g., Rocheleau 1988) and are determined by religion and social norms (Howard and Nabanoga 2007). Local knowledge of plant ecology (e.g., Gómez-Baggethun et al. 2010) and ethnobotany (e.g., Voeks 2007) was shown to increase with age, and this in turn could cause differences in the use, management, and perceptions of noncultivated plant resources between age groups. For landscape planning purposes, aiming at combining land use and biodiversity conservation in a sustainable way based on user-group consensus, it is important to know whether such differences between gender and age groups of the main stakeholders also exist in non-protected areas and whether and how this is reflected in the spatial distribution of land and resource uses and perceptions on disturbances of plant biodiversity.

Noncultivated Plants and Rural Communities: Research Objectives

The objectives of this study were therefore threefold: (1) to investigate the way local communities use and manage noncultivated plant resources, how this relates to agricultural land-use and plant biodiversity conservation, and whether this differs among gender and age groups, (2) to elucidate the level of awareness of rural communities on environmental changes, from a plant resource perspective, and their own role in this as users of noncultivated and in situ managed plants, and (3) to identify forms of plant biodiversity conservation by rural communities in landscapes without a formal protection status. The overall aims were to gather insights in the interdependent relations between the local rural population and their surrounding plant resources, in order to contribute to the discussion on strategies for sustainable agricultural land use and biodiversity conservation in a landscape without formal protection status. We have chosen southern Benin and Togo for this case study, as this area harbors one of the global "biodiversity hot spots," which are locations where exceptional concentrations of endemic species are undergoing exceptional losses of habitat (Myers et al. 2000).

Study Area

The study was carried out in three villages in the Zou-Mono area of southwest Benin, Agohoué-Balimé, Eglimé, and Badjamé, and three villages in southeast Togo, Badjegohoué, Adjahoué, and Hahomegbé (Figure 1). These sites are located in the so-called Dahomey Gap, characterized by a lower rainfall compared to the typical forest zone of West Africa. The Southern Guinea Savannah zone, to which the study sites belong, has a bimodal rainfall regime. The six villages are in close vicinity to four inland valleys (two in each country), covering the whole upland–lowland ecosystem continuum. They are representative for the area, as inland valleys cover an estimated 205,000 ha in Benin and 240,000 ha in Togo (AfricaRice 2008).

The villages are surrounded by agricultural fields and unexploited terrain characterized by savannah vegetation (e.g., grassland, shrubs, trees, and small forest reserves). The main economic activity in the study area is agriculture, with maize (*Zea mays*), cassava (*Manihot esculenta*), rice (*Oryza sativa* and *O. glaberrima*), cotton (*Gossypium herbaceum*), oil palm (*Elaeis guineensis*), and a variety of fruits and vegetables as main crops. Farming systems are generally of small scale, highly diverse, and subsistence oriented. Through human activities like logging for timber and firewood, and slash-and-burn for agriculture, most of the original vegetation is replaced by secondary grasslands or thickets. The flora of the two countries are comparable and estimated to contain at least 3,000 species (Adomou et al. 2007; Akpagana and Bouchet 1994). Adja and Ewe are the prevailing language groups in the study sites.

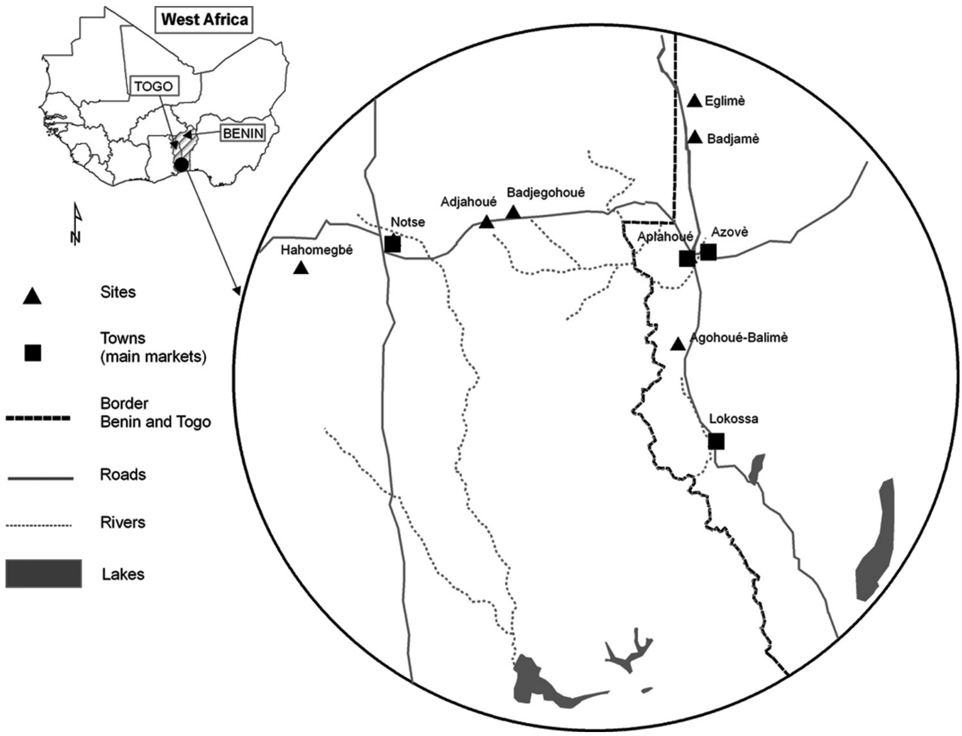

Figure 1. Study area indicating sites (villages: Hahomègbé, Adjahoué, and Badjegohoué in Togo and Eglimé, Badjamè, and Agohoué-Balimé in Benin) and nearby towns (Notsè, Azovè, Aplahoué, and Lokossa).

Methodologies

Interviews

Between November 2005 and February 2006, in total 106 local community members from six villages, equally divided over Benin and Togo, were interviewed. We surveyed users of plant resources in the inland valleys, representing common, multifunctional landscapes without formal protection status. The six villages accommodate users of four such inland valleys. We have conducted three types of interviews: (1) with key informants, (2) with individual local users of these inland valleys, and (3) with local user groups. Only the key informants were selected from all the six villages, while individual local users were selected among community members from the four villages (two in Benin and two in Togo) that were closest to the four inland valleys in the study area. The user groups contained both the key informants from the total six villages and the local users from the four villages nearest to inland valleys. Interviews were conducted with the help of two trained interpreters, communicating the questions in the local languages (Adja and Ewe) and translating the responses back in French.

Site Selection

The villages were selected with assistance of local extension services and based on five main criteria; they had to (1) be representative of the study area and the wider agro-ecological zone (southern Guinea Savannah), (2) be users of a nearby inland valley (upland-lowland continuum), (3) be located at reasonable travel distance (maximum 80 km) from other study sites, (4) have comparable ethnical, geographical and ecological characteristics, and (5) accommodate enough potential respondents with a willingness to cooperate to our surveys.

Key Informants

Semistructured interviews were held among 30 key informants on noncultivated plant species, equally divided over the six villages. These key informants, in all cases traditional healers, were selected after reaching a village-wide consensus on the question ''Who knows most about plant resources?'' The key informants were asked to indicate important use categories, collection locations, reasons for decline, and management practices of useful noncultivated plant species.

Local Users

The key informant responses were subsequently used to design a questionnaire for structured and semistructured interviews of individual community members, hereafter also referred to as local users. These interviews were held in two villages in each country: Badjegohoué and Hahomegbé in Togo and Agohoué-Balimé and Eglimé in Benin. As advocated by Kristensen and Lykke (2003), it is important to include a broad representation of the society in surveys on local natural resource management. Therefore, and in order to get information about possible gender and age effects on the use and management issues under investigation, we aimed at interviewing a representative sample of local users. To this end, we used a stratified sampling method with four villages and four gender and age categories. The four categories were men younger than 30 years of age, men older than 30, women younger than 30, and women older than 30. Within each category, four or five respondents were selected on the basis of their availability and willingness to cooperate. The total sample size of these individual ''local users'' interviews was 76. Questionnaires included ranking and open questions on use purposes, collection locations, abundance, and disturbance of noncultivated plant diversity.

Local User Groups

Key informant and local user interviews were followed by structured group discussions with local users from the four main villages and key informants from all six villages. In total, 20 local user groups, each containing five individuals, were interviewed. Local user groups were women older than 30 years (four groups), women younger than 30 (four groups), men older than 30 (two groups), men younger than 30 (four groups), and the earlier mentioned groups of local experts (one group in each village). In villages where individual interviews were done, the same respondents were asked to participate in these group interviews to the extent possible. Following Gausset (2004), all groups were asked to name the 10 noncultivated plant species that are most important to them in terms of irreplaceability (also referred to as ''perceived irreplaceability''). Subsequently, groups were asked about the use purpose (earlier identified by key informants), abundance, frequency of use, and management practices of these species.

During these interviews, key informants and local users listed species by their local names. To identify taxonomic names, their responses were immediately cross-checked using a field herbarium. We collected samples of the species we could not immediately identify in the field and conducted their taxonomic identification at a later stage, consulting the Benin Analytical Flora (Akoègninou et al. 2006) and the National Herbarium of Benin, at the University of Abomey-Calavi.

Rankings and Analyses

In structured questionnaires, respondents were asked to rate plant use purpose, collection location, and disturbance sources on a scale from 1 to 5, 6, or 8 (depending on number of categories), where higher numbers indicated increasing importance of the category. For abundance (ease of finding) and changes in abundance (species dynamics) we used nominal classes (e.g., "easy," "difficult" and "increased," "decreased"). For statistical analyses we used SPSS version 10.0 for Windows. Nominal (gender) and ordinal data (age classes) were analyzed with one-way analysis of variance (ANOVA).

Definitions and Terminology

Throughout this study we consistently used the same terminology and thoroughly explained terms' meanings to interpreters and respondents to avoid possible confusion. We used the term "noncultivated species" to indicate all species that are part of spontaneous vegetation, including native, exotic, and in situ managed ones. The term "noncultivated" plants has been used previously in a similar context (e.g., Leonti et al. 2006) and refers to plants that grow spontaneously, self-maintained and independently of direct human action, in natural and seminatural environments (Heywood 1999). With "in situ managed plants" we refer to individual plants that local users maintain, encourage, and protect during and following clearance of vegetation (e.g., Casas et al. 2007). The term "perceived irreplaceability" is defined as the extent to which species are considered irreplaceable by local users. On the level of collection location we distinguished (1) "forest," comprising relatively undisturbed ecosystems dominated by tree species; (2) "field," being agricultural production spaces dominated by crops and weed species during the cropping season and pioneer fallow species during the off-season; (3) "village," built-up and inhabited areas; (4) "bush," the unexploited areas surrounding the fields and villages; and (5) the "market," local public places where products are bought and sold. The latter distinction is important as we are interested in the assumed trade-offs between local land use and (noncultivated) plant biodiversity and the hypothesis that the collection locations for useful plant species would differ between men and women, following the concept of spatial gender differentiations in biodiversity use as suggested previously (e.g., Pfeiffer and Butz 2005).

Use and Management of Noncultivated Plants and Perceptions of Their Abundance and Disturbance: Survey Results

Use of Noncultivated Plants

Interviews with key informants revealed eight use categories for noncultivated plants: food, firewood ("fuel"), medicines, construction (e.g., houses, storage rooms,

Table 1. Ranking of use frequency of different categories of wild plant use according to local communities of two villages in Benin and two in Togo (1 = least used to 8 = most often used; data derived from (semi)structured interviews of 76 individual local users in 4 sites), and the number of times a category is associated (frequency) with a collected wild plant part

	Togo		Benin					Gender		Age (years)	
Use category	Badjegohoué	Hahomegbé	Agohoué-Balimé	Eglimé	Mean	Frequency	%	Men	Women	<30	>30
Food	7.6	6.2	7.0	7.4	7.1	43	10	7.0	7.1	7.1	6.9
Firewood	6.0	6.7	6.6	6.8	6.5	79	18	6.2b[a,b]	6.8a	6.5	6.7
Medicines	6.9	6.4	6.3	6.0	6.4	159	37	6.4	6.3	6.4	6.3
Construction	4.9	5.4	5.5	4.7	5.1	64	15	5.6a[c]	4.7b	4.8	5.5
Household	3.2	4.1	3.5	4.2	3.8	45	10	3.7	3.8	3.7	3.9
Crop protection	2.3	3.7	2.8	3.5	3.1	11	3	2.9	3.2	3.3	2.8
Traditions and ceremonies	2.4	1.8	2.4	0.5	1.8	25	6	1.7	1.9	1.4b[d]	2.2a
Fishing and hunting	1.2	0.7	0.6	0.5	0.8	4	1	0.9	0.6	0.9	0.5
n	18	19	20	19	76	430	100	35	41	42	34

[a]Means, within each line, followed by a different letter (a, b) are significantly different ($p < .05$) according to the independent-sample *t* test.
[b]Standard error of difference (SED): 0.29; $p = .035$.
[c]SED: 0.41; $p = .044$.
[d]SED: 0.40; $p = .047$.

furniture), household (comprising all uses in-and-around the house that cannot be classified in other categories), crop protection (including protection of storage of agricultural produce), traditions and ceremonies (including voodoo practices), and fishing and hunting. Noncultivated plants were most frequently used for food, fuel and medicinal purposes (Table 1). Traditions and ceremonies, and fishing and hunting were least frequently mentioned as purposes. Men ranked construction wood, as a purpose for noncultivated plant material, significantly ($p < .05$) higher than women, while the reverse was true for firewood (Table 1). The group of participants older than 30 years ranked the category "traditions and ceremonies" significantly higher than the group of correspondents younger than 30.

In total, 87 different noncultivated plant species, from 39 families, were mentioned by the 20 user groups as most important in terms of perceived irreplaceability (see Appendix). The majority (85%) of these species are perennial (35 trees, 12 tree-shrubs, 9 shrubs, 10 forbs, 5 vines or vine-shrubs, and 3 forbs/shrubs), while 4 forb species can either be classified as annual or perennial, and only 9 species (all forbs) are truly annual. Using only responses from the local users of the four main sites ($n = 76$), we counted 81 different species that were associated with 430 different uses divided over eight use categories (Table 1). One species, or even one plant part of a species, can serve more than one purpose. Most of these plant parts (159) were valued for medicinal purposes, followed by firewood (79) and construction wood (64), household purposes (45), and food (43). Hence, while food ranked highest as an objective for noncultivated plant collection, only 10% of the most valuable species mentioned actually served this purpose (Table 1).

Locations to Collect Noncultivated Plants

Useful noncultivated plants were found in the bush, on agricultural fields, in the forests, and in and around the villages (Table 2). In cases when the species could not be found in any of these locations, they were purchased at the local market. These comprise species that were previously available in the study area but, due to their increased scarcity, are currently harvested elsewhere. There were no significant ($p < .05$) differences between gender and age groups for the importance of location for the collection of noncultivated plants. Based on the scores averaged over the four sites, bush and agricultural fields were

Table 2. Relative importance (mean ranks) of the location for collection of wild plant material per site, with data from (semi)structured interviews with 76 local users in four sites

	Togo		Benin		
Location	Badjegohoué	Hahomegbé	Agohoué-Balimé	Eglimé	Mean
Bush	2.5[a]	3.5	4.8	4.8	3.9
Field	4.2	3.7	4.0	3.8	3.9
Village	4.4	3.1	2.8	4.1	3.6
Market	0.8	1.2	2.0	1.9	1.5
Forest	2.2	2.9	0.5	0.2	1.5

[a]Values in the table represent mean ranks between 0 (never visited) and 5 (most often visited).

Table 3. Relative importance (mean ranks) of factors for decline of wild plant diversity per site, according to 76 local users, with data from (semi)structured interviews in four sites

Factors for decline of plant diversity	Togo		Benin		Mean for all sites and countries
	Badjegohoué	Hahomegbé	Agohoué-Balimé	Eglimé	
Hunting	4.8	4.5	4.8	4.6	4.7
Agriculture	3.3	3.9	4.8	4.3	4.1
Construction	4.2	3.4	3.1	4.0	3.7
Droughts & floods	3.8	3.1	3.2	3.4	3.4
Collecting	2.9	3.2	3.7	3.6	3.4
Herding	0.6	2.4	1.5	1.1	1.4
n	18	19	20	19	

Note. Values are mean ranks based on interdependent ranks from 1 to 6 in increasing importance (categories not mentioned received a zero score).

the most important locations for rural people to find useful noncultivated plant material (Table 2). Agricultural fields received consistently high scores in all sites.

Plant Species Decline

According to the vast majority of respondents (91%), diversity of noncultivated plant species has decreased over time. In open interviews, individuals mentioned several reasons for this decline. Human population increase was the overarching explanation, as it increased the need for food, fuel, and housing, augmenting the pressure on land and natural vegetation.

Six main reasons for decline in plant diversity were retrieved from interviews with the key informants: agriculture, cattle herding, collecting of noncultivated plants, construction, droughts or floods, and hunting. These six categories were used for structured interviews. In all sites, hunting was perceived as the most important reason for decline of plant diversity, followed by agriculture and construction (Table 3). For the importance scores given to disturbances to noncultivated plant diversity, there were no significant differences between gender and age classes. For hunting, natural vegetation is set on fire to chase wild animals such as the rodents great cane rat (*Thryonomys swinderianus*) and African savanna hare (*Lepus microtus*). Open interviews revealed that local people know that this exerts a specific impact on the natural vegetation. The occurrence of droughts and floods and the collection of noncultivated plants were found to be of equal importance as sources of disturbance to plant biodiversity.

Fourteen out of the 87 species mentioned in this study were highly sought after and difficult to find, according to local respondents. They pointed out that some of these species could not be cultivated as the species were difficult to propagate and the respondents lacked specific knowledge on their regeneration biology.

Management Practices

Of the 87 useful noncultivated species mentioned in this study, 57 (66%) were managed in one way or another. No overlap was found between these 57 species and the 14 species mentioned as highly sought after and difficult to find. Open interviews with key informants and local user groups revealed the existence of three types of management practices in the research sites: (1) minimizing disturbance to assure plant life and regeneration; (2) maintaining valuable, spontaneously established, plants on agricultural fields, either during land clearing or during weeding in existing crops; and (3) planting and nourishing. In Badjamé (Benin), a 12-ha community-managed forest reserve was observed. In Agohoué-Balimé (Benin), traditional healers managed valuable medicinal plant species on a 2-ha community garden containing around 300 species, and the same village had a similar-sized community forest reserve. From the forest reserves in both villages in Benin, community members were only allowed to selectively collect plant parts, but not whole plants. No organized forms of plant species' conservation were observed in other villages.

Rural Community Management of Noncultivated Plant Resources: Between Cultivation and Conservation

This study shows that in the Southern Guinea savannah of Africa, noncultivated plant species are frequently used by a variety of local community members and for a wide range of purposes. More than half (54%) of the useful species identified in this study are woody species. This confirms their importance in African rural communities, as earlier observed by Smith et al. (1996). In addition, depending on the context, some of the useful noncultivated plant species mentioned by respondents in this study could also be classified as "cultivated" as they not only feature in spontaneous vegetation but can also often be found in orchards, home gardens, or production forests. Examples of these are mango (*Mangifera indica*), papaya (*Carica papaya*), teak (*T. grandis*), oil palm (*Elaeis guineensis*), coconut palm (*Cocos nucifera*), cassava (*Manihot esculenta*), lime/sour orange (*Citrus* spp.), ginger (*Zingiber officinalis*), and jatropha (*Jatropha* spp.). In many cases these useful plants might be individuals, or offspring of these individuals, remaining after previous human interventions or be spontaneously emerged from spread seeds. From this we conclude that at least for local users, a strict distinction between cultivated and noncultivated seems irrelevant. Similar ambiguities were reported by Leonti et al. (2006) and Heywood (1999). More than 88% of all reported useful noncultivated plants in this study have medicinal purposes, confirming that traditional medicines derived from plant resources play an important role in African rural societies (e.g., Hermans et al. 2004).

The study further revealed that local user groups prioritize both species with a multitude of functions, as was earlier observed by Styger et al. (1999), and species with a unique function (e.g., medicinal) that cannot be substituted by any other species. Other species that merit conservation priority according to local users are those that carry a high value and are at the same time difficult to manage. Examples of these are the timber species *Afzelia africana, Milicia excelsa,* and *Pterocarpus erinaceus*. Although these species were considered common in West Africa (e.g., Kristensen and Lykke 2003), they suffer from unsustainable exploitation as reported earlier in Nigeria (Osemeobo 1992), Benin (e.g., Sinsin et al. 2004), and Burkina Faso (Lykke 2000). In our study *Pterocarpus erinaceus, Milicia excelsa, Afzelia africana, Antiaris toxicaria, Strophanthus hispidus,* and *Phyllanthus muellerianus* were highly sought after and difficult to find, yet still used as firewood by the same respondents. This contrasts with findings of Kristensen and Balslev (2003) from a study carried out in Burkina Faso that show that species declining in abundance are not used by local people for firewood. Our study shows that local knowledge about rarity of species does not always lead to conservation, management, or even reduced use. However, most other species (66% of all species mentioned) are in some way protected or well managed.

Local people are not ignorant of environmental change, as was shown by our study. According to the respondents, noncultivated plant biodiversity is declining over time. This perception confirms earlier findings from Africa (e.g., Bollig and Schulte 1999). However, in our study the locally perceived causes of these changes differ from what was reported so far. Local users in our study indicated that the top three most important reasons for this decline are hunting, agriculture, and construction, all human causes. This contrasts with the commonly observed perception among rural people in Africa that disregards human causes and emphasizes environmental causes (e.g., rainfall variability) of degradation (e.g., Bollig and Schulte 1999; Heywood 1999; Lykke 2000). While agriculture is seen as one of the main causes for decline in plant biodiversity, agricultural fields are also considered the most important locations (together with the bush) to collect useful noncultivated plants. This could partly be caused by the lack of remaining forests in these nonprotected landscapes and the more difficult access to forests compared to agricultural fields, and partly because noncultivated plants in agricultural fields (weeds) comprise an important share of useful species. Weed species indeed frequently feature in pharmacopoeias (e.g., Stepp and Moerman 2001). Of the useful species that can be categorized as weed or invasive species, medical purposes were by far the most frequent uses (90%), but these species were also used to supplement local demands for food, domestic purposes, traditions and ceremonies, crop protection, and fuel, confirming previous observations from other parts of Africa (Hillocks 1998) and Latin America (Blanckaert et al. 2007). Farmers in the study area recognize these useful species during weeding and either maintain them in the crop or keep them apart from the bulk of other uprooted weeds. These purposes and practices have been reported before (see references in Rodenburg and Johnson 2009). In addition, we observed that at field clearing useful species (primarily trees) are maintained, a practice more frequently observed in (West) Africa (e.g., Kristensen and Lykke 2003; Leach 1991; Madge 1995) and an increasingly common strategy to deal with the decline of forests (Shepherd 1992). In contrast with earlier studies (e.g., Styger et al. 1999; Vodouhe et al. 2009; Voeks 2007), we observed few age and gender differences in local use, management, and perception of noncultivated plant resources. In line with Vodouhe et al. (2009), we found that men value woody species for construction whereas women value them for use as firewood. This could be explained by gender differences in responsibilities (Howard and Nabanoga 2007; Rocheleau 1988). However, other findings by Vodouhe et al. (2009), for instance, that women value species used for food more than men, were not confirmed by our study. We also found no evidence for the existence of age or gender differentiation in collection locations (“gendered spaces”) for useful plants previously suggested by Pfeiffer and Butz (2005) and Howard and Nabanoga (2007). Using two broad categories (''old'' and ''young''), we also found no age differentiation in the collection locations of useful plants or in the perceptions on disturbance of plant biodiversity. The only age-related difference we observed was in use purposes of noncultivated plants; people older than 30 years of age gave a higher priority to ''traditions and ceremonies,'' which is logically related to life history and experience. Young people generally have less affinity with traditions than older people (e.g., Lebbie and Freudenberger 1996).

Despite the broad use of noncultivated plant species in these unprotected areas, organized, community-based conservation practices were only observed in Agohoué-Balimé and Badjamé (Benin). One of these organized forms was the management of a small community forest reserve, similar to conservation forms observed in other parts of Africa (Brockington 2007; Lebbie and Freudenberger 1996; Warren and Pinkston 1998). The other organized form of plant biodiversity conservation was the establishment of a community garden. Apart from numerous studies on biodiversity conservation in home gardens (e.g., Perfecto and Vandermeer 2008), we are not aware of any previous reports on a similar community conservation initiative of this scale (2 ha, containing around 300 species) as found in our study. Apart from these initiatives, 66% of the useful species identified in this study received some form of protection albeit on a more ad hoc basis. In many cases, in order to save the plant itself, only useful plant parts (e.g., leaves, fruits, bark) were harvested. However, this may not always be a sustainable management practice in the long term (Delvaux et al. 2009), especially when pressure on natural resources increases due to population growth. Consequently, establishment of medicinal plant gardens, either commercially or community-based, like the one observed in Benin in this study, may be a more vital strategy to sustain the use of such species (Jager and Van Staden 2000). This also applies to species with traditional food, domestic, or cultural purposes. Agricultural fields were ranked as the second most important place to collect noncultivated plant species in all the study sites, showing their potential as areas to manage plant resources that are not cultivated in a conventional way. Agriculture may as such play a role in the conservation of (noncultivated) plant resources in landscapes lacking formal protection status. This confirms suggestions made by Dixon and Wood (2003) that, rather than being two strictly opposite approaches, agricultural development and biodiversity conservation could go hand in hand.

Sustainable Land Use in Nonprotected Landscapes: Acknowledging Knowledge and Needs of Local Communities

The aim of this study was to contribute to the development of strategies for the sustainable use of inland-valleys ecosystem functions in landscapes lacking formal protection, aligning agriculture and biodiversity conservation. Sustainable use of these ecosystems is important particularly in developing countries, as it presumes to encompass both economic and ecological objectives, balancing local livelihoods with biodiversity conservation (e.g., Wyman and Stein 2010). The current study showed that rural communities in southern Benin and Togo value and use noncultivated plants on a broad scale. This is reflected in the variety of both user groups and use purposes. Consequently, there is an understanding of the need of plant diversity conservation and there is a willingness to contribute to it. Concerted and individual efforts to conserve or manage useful noncultivated species in ways that were observed in this study (e.g., community-managed plant gardens and small forest reserves) could alleviate the pressure on plant biodiversity in undisturbed or unexploited areas. Agriculture can be an important disturbing factor for plant diversity, but can also play a role in its conservation. Species that are frequently collected and consequently threatened in their existence can be grown in designated agricultural fields or community gardens if earlier reported propagation problems can be overcome (this might require more research in generation biology of specific species, followed by training). Moreover, agriculture also inherently creates conditions that favor the growth and collection of some useful species. As the vital roles these species can play in complementing food, medicinal, and domestic needs of rural households are often overlooked by intervening development projects, the role and importance of noncultivated species should be included in formal agricultural training curricula. This should be part of a broader effort to build ecological and sociotechnological literacy among stakeholders (e.g., Van Mele 2008).

In agreement with recent insights (e.g., Del Amo-Rodriguez et al. 2010; Perfecto and Vandermeer 2008), we conclude that future projects aiming at sustainable land use (including agriculture and biodiversity conservation), in particular in fragile and high potential ecosystems such as inland valleys without formal protection status, should strive for active participation of all stakeholders similar to approaches proposed by McCartney and Houghton (2009) and Brockington (2007). We recognize that this will most likely not be an easy task, as highlighted by Mahanty and Russell (2002), but we consider it a prerequisite to stimulate the dialogue between agricultural professionals of different disciplines (e.g., weed scientists, sociologists, and botanists), conservationists, and local user groups, necessary for sustainable and successful natural resource management. Next steps would include the participatory identification and mapping of biodiversity hot spots within the upland–lowland continuum under consideration. Local users should be given the opportunity to prioritize the noncultivated plant species and collection places they wish to safeguard and to express their needs in terms of training or support benefiting already existing conservation or management practices. This could lead to a strategic plan for local (agricultural) land use and conservation efforts for landscapes lacking formal protection status, with designated areas for agricultural production and areas that are maintained or managed to fulfill other ecosystem functions, resulting in the putative (environmentally and socially) sustainable, spatially and temporally mixed, land use forms as earlier proposed by Dixon and Wood (2003). As agricultural fields are important locations for the collection of useful plant species, the information obtained through the stakeholder participatory priority exercises should be integrated in the local agricultural development agenda and proposed production systems and crop protection (weed management) strategies in order to safeguard the multiple local use functions of cropped areas.

The herewith proposed approach, based on our case study in southern Benin and Togo, is a starting point to develop strategies of concerted agricultural development and biodiversity conservation that can be adjusted according to local conditions and newly acquired insights. Local communities in rural Africa are heavily dependent on the natural resources surrounding them. As the primary users and managers of plant resources, they are the most important stakeholders. Any land-use development or conservation initiative ought to acknowledge their knowledge and needs, and address shortcomings, to establish a basis for sustainable land use.

References

Adomou, A. C., A. Akoègninou, B. Sinsin, B. de Foucault, and L. J. G. Van der Maesen. 2007. Notulae Florae Beninensis, 13—Biogeographical analysis of the vegetation in Benin. *Acta Bot. Gallica* 154(2):221–233.

AfricaRice. 2008. The West Africa Inland Valley Information System (WAIVIS). Africa Rice Center. http://www.africarice.org/WAiVIS (accessed 15 March 2010).

Akoègninou, A., W. J. van der Burg, and L. J. G. Van der Maesen. 2006. *Flore Analytique du Bénin* [Analytical Flora of Benin]. Leiden, the Netherlands: Backhuys Publishers.

Akpagana, K., and P. Bouchet. 1994. Present KNOWLEDGE ON FLORA AND VEG-Etation of Togo. *Acta Bot. Gallica* 141(3):367–372.

Blanckaert, I., K. Vancraeynest, R. L. Swennen, F. J. Espinosa-Garcia, D. Pinero, and R. Lira-Saade. 2007. Non-crop resources and the role of indigenous knowledge in semi-arid production of Mexico. *Agric. Ecosystems Environ.* 119(1–2):39–48.

Bollig, M., and A. Schulte. 1999. Environmental change and pastoral perceptions: Degradation and indigenous knowledge in two African pastoral communities. *Hum. Ecol.* 27(3):493–514.

Brockington, D. 2007. Forests, community conservation, and local government performance: The village forest reserves of Tanzania. *Society Nat. Resources* 20:835–848.

Casas, A., A. Otero-Arnaiz, E. Pérez-Negrón, and A. Valiente-Banuet. 2007. In situ management and domestication of plants in Mesoamerica. *Ann. Bot.* 100(5):1101–1115.

Casas, A., A. Valiente-Banuet, J. L. Viveros, J. Caballero, L. Cortes, P. Davila, R. Lira, and I. Rodriguez. 2001. Plant resources of the Tehuacan-Cuicatlan Valley. Mexico. *Econ. Bot.* 55(1):129–166.

Dansi, A., A. Adjatin, H. Adoukonou-Sagbadja, V. Falade, H. Yedomonhan, D. Odou, and B. Dossou. 2008. Traditional leafy vegetables and their use in the Benin Republic. *Genet. Res. Crop Evol.* 55(8):1239–1256.

Del Amo-Rodriguez, S., M. D. Vergara-Tenorio, J. M. Ramos-Prado, and L. Porter-Bolland. 2010. Community landscape planning for rural areas: A model for biocultural resource management. *Society Nat. Resources* 23:436–450.

Delvaux, C., B. Sinsin, F. Darchambeau, and P. Van Damme. 2009. Recovery from bark harvesting of 12 medicinal tree species in Benin, West Africa. *J. Appl. Ecol.* 46(3):703–712.

Dietz, T., E. Ostrom, and P. C. Stern. 2003. The struggle to govern the commons. *Science* 302:1907–1912.

Dixon, A. B., and A. P. Wood. 2003. Wetland cultivation and hydrological management in eastern Africa: Matching community and hydrological needs through sustainable wetland use. *Nat. Resources Forum* 27(2):117–129.

Etkin, N. L. 2002. Local knowledge of biotic diversity and its conservation in rural Hausaland, Northern Nigeria. *Econ. Bot.* 56(1):73–88.

Gardner, T. A., T. Caro, E. B. Fitzherbert, T. Banda, and P. Lalbhai. 2007. Conservation value of multiple-use areas in East Africa. *Conserv. Biol.* 21(6):1516–1525.

Gausset, Q. 2004. Ranking local tree needs and priorities through an interdisciplinary action approach. *J. Transdiscip. Environ. Stud.* 3(1):1–17.

Gómez-Baggethun, E., S. Mingorría, V. Reyes-García, L. Calvet, and C. Montes. 2010. Traditional ecological knowledge trends in the transition to a market economy: Empirical study in the Doñana Natural Areas. *Conserv. Biol.* 24(3):721–729.

Hermans, M., A. Akoègninou, and L. J. G. Van der Maesen. 2004. Medicinal plants used to treat malaria in southern Benin. *Econ. Bot.* 58:S239–S252.

Heywood, V. 1999. *Use and potential of wild plants in farm households. FAO farm systems management series: 15*. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).

Hillocks, R. J. 1998. The potential benefits of weeds with reference to small holder agriculture in Africa. *Integrated. Pest Manage. Rev.* 3:155–167.

Honnay, O., H. Jacquemyn, B. Bossuyt, and M. Hermy. 2005. Forest fragmentation effects on patch occupancy and population viability of herbaceous plant species. *New Phytol.* 166(3):723–736.

Howard, P. L., and G. Nabanoga. 2007. Are there customary rights to plants? An inquiry among the Baganda (Uganda), with special attention to gender. *World Dev.* 35(9):1542–1563.

Jager, A. K., and J. Van Staden. 2000. The need for cultivation of medicinal plants in southern Africa. *Outlook Agric.* 29(4):283–284.

Kristensen, M. K., and H. Balslev. 2003. Perceptions, use and availability of woody plants among the Gourounsi in Burkina Faso. *Biodivers. Conserv.* 12(8):1715–1739.

Kristensen, M. K., and A. M. Lykke. 2003. Informant-based valuation of use and conservation preferences of savanna trees in Burkina Faso. *Econ. Bot.* 57(2):203–217.

Leach, M. 1991. Engendered environments: Understanding natural resource management in the West African forest zone. *IDS Bull.* 22(4):17–24.

Lebbie, A. R., and M. S. Freudenberger. 1996. Sacred groves in Africa: Forest patches in transition. In *Forest patches in tropical landscapes*, ed. J. Schelhas and R. Greenberg, 300–324. Washington, DC: Island Press.

Leonti, M., S. Nebel, D. Rivera, and M. Heinrich. 2006. Wild gathered food plants in the European Mediterranean: A comparative analysis. *Econ. Bot.* 60(2):130–142.

Lykke, A. M. 2000. Local perceptions of vegetation change and priorities for conservation of woody-savanna vegetation in Senegal. *J. Environ. Manage.* 59(2):107–120.

Madge, C. 1995. Ethnography and agroforestry research: A case study from the Gambia. *Agrofor. Systems* 32(2):127–146.

Mahanty, S., and D. Russell. 2002. High stakes: Lessons from stakeholder groups in the biodiversity conservation network. *Society Nat. Resources* 15:179–188.

McCartney, M. P., and H. A. Houghton-Carr. 2009. Working wetland potential: An index to guide the sustainable development of African wetlands. *Nat. Resources Forum* 33(2):99–110.

Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. da Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403(6772):853–858.

Okello, M. M., S. K. O. Seno, and R. W. Nthiga. 2009. Reconciling people's livelihoods and environmental conservation in the rural landscapes in Kenya: Opportunities and challenges in the Amboseli landscapes. *Nat. Resources Forum* 33(2):123–133.

Osemeobo, G. J. 1992. Land-use issues on wild plant conservation in Nigeria. *J. Environ. Manage.* 36(1):17–26.

Perfecto, I., and J. Vandermeer. 2008. Biodiversity conservation in tropical agroecosystems—A new conservation paradigm. *Ann. New York Acad. Sciences* 1134(1):173–200.

Pfeiffer, J. M., and R. J. Butz. 2005. Assessing cultural and ecological variation in ethnobiological research: The importance of gender. *J. Ethnobiol.* 25(2):240–278.

Pretty, J., and D. Smith. 2004. Social capital in biodiversity conservation and management. *Conserv. Biol.* 18(3):631–638.

Redford, K. H., and S. E. Sanderson. 2000. Extracting humans from nature. *Conserv. Biol.* 14(5):1362–1364.

Rocheleau, D. E. 1988. Gender, resource management and the rual landscape: Implications for agroforestry and farming systems research. In *Gender issues in farming systems research and extension*, ed. S. V. Poats, M. Schmink, and A. Spring, 149–169. Boulder, CO: Westview Press.

Rodenburg, J., and D. E. Johnson. 2009. Weed management in rice-based cropping systems in Africa. *Adv. Agron.* 103:149–218.

Schwartzman, S., A. Moreira, and D. Nepstad. 2000a. Rethinking tropical forest conservation: Perils in Parks. *Conserv. Biol.* 14(5):1351–1357.

Schwartzman, S., D. Nepstad, and A. Moreira. 2000b. Arguing tropical forest conservation: people versus parks. *Conserv. Biol.* 14(5):1370–1374.

Shepherd, G. 1992. *Managing Africa's tropical dry forests: A review of indigenous methods*. London, UK: Overseas Development Institute.

Sick, D. 2008. Social contexts and consequences of institutional change in common-pool resource management. *Society Nat. Resources* 21:94–105.

Silvius, M. J., M. Oneka, and A. Verhagen. 2000. Wetlands: Lifeline for people at the edge. *Phys. Chem. Earth Part B Hydrol. Oceans Atmos.* 25(7–8):645–652.

Sinsin, B., O. E. Matig, A. E. Assogbadjo, O. G. Gaoue, and T. Sinadouwirou. 2004. Dendrometric characteristics as indicators of pressure of *Afzelia africana* Sm. dynamic changes in trees found in different climatic zones of Benin. *Biodivers. Conserv.* 13(8):1555–1570.

Smith, W., T. C. Meredith, and T. Johns. 1996. Use and conservation of woody vegetation by the Batemi of Ngorongoro District, Tanzania. *Econ. Bot.* 50(3):290–299.

Stepp, J. R., and D. E. Moerman. 2001. The importance of weeds in ethnopharmacology. *J. Ethnopharmacol.* 75(1):19–23.

Styger, E., J. E. M. Rakotoarimanana, R. Rabevohitra, and E. C. M. Fernandes. 1999. Indigenous fruit trees of Madagascar: Potential components of agroforestry systems to improve human nutrition and restore biological diversity. *Agrofor. Sys.* 46:289–310.

Swift, M. J., A. M. N. Izac, and M. van Noordwijk. 2004. Biodiversity and ecosystem services in agricultural landscapes—are we asking the right questions? *Agric. Ecosystems Environ.* 104(1):113–134.

Terborgh, J. 2000. The fate of tropical forests: A matter of stewardship. *Conserv. Biol.* 14(5):1358–1361.

Van Mele, P. 2008. The importance of ecological and socio-technological literacy in R&D priority setting: The case of a fruit innovation system in Guinea, West Africa. *Int. J. Agric. Sustain.* 6:183–194.

Vodouhe, F. G., O. Coulibaly, C. Greene, and B. Sinsin. 2009. Estimating the local value of non-timber forest products to Pendjari Biosphere Reserve dwellers in Benin. *Econ. Bot.* 63(4):397–412.

Voeks, R. A. 2007. Are women reservoirs of traditional plant knowledge? Gender, ethnobotany and globalization in northeast Brazil. *Singapore J. Trop. Geogr.* 28(1):7–20.

Warren, D. M., and J. Pinkston. 1998. Indigenous African resource management of a tropical rain forest ecosystem: A case study of the Yoruba of Ara, Nigeria. In *Linking social and ecological systems: Management practices and social mechanisms for building resilience*, ed. F. Berkes and C. Folke, 158–189. Cambridge, UK: Cambridge University Press.

Wilson, D. 1997. Culture, conservation, and biodiversity: The social dimension of linking local-level development and conservation through protected areas. *Society Nat. Resources* 10:595–597.

Wyman, M., and T. Stein. 2010. Examining the linkages between community benefits, place-based meanings, and conservation program involvement: A study within the community baboon sanctuary, Belize. *Society Nat. Resources* 23:542–556.

Appendix

Useful plant species (alphabetic order) prioritized by key informants ($n = 30$) and local users ($n = 76$) in six villages in Benin and Togo (2005–2006)

Species	Family	Local use
Abrus precatorius	Fabaceae	M
Acmella uliginosa	Asteraceae	M
Adansonia digitata	Malvaceae	Fo, M, H
Afzelia africana	Fabaceae	Fi, T
Amaranthus viridis	Amaranthaceae	M
Anogeissus leiocarpa	Combretaceae	M, H, T, D
Antiaris toxicaria	Moraceae	Fi, C, H
Azadirachta indica	Meliaceae	M, Fi, C, H, T
Blighia sapida	Sapindaceae	Fo, M, Fi, C, T
Bombax brevicuspe	Bombacaceae	M, T
Borassus aethiopum	Arecaceae	Fo, C
Bridelia ferruginea	Phyllanthaceae	M
Caesalpinia benthamiana	Fabaceae	M
Caesalpinia bonduc	Fabaceae	M, T
Caesalpinia pulcherrima	Fabaceae	M, H, T
Carica papaya	Caricaceae	Fo, M
Ceiba pentandra	Bombacaceae	C, H, FH
Chassalia kolly	Rubiaceae	M
Chromolaena odorata	Asteraceae	M
Citrus aurantifolia	Rutaceae	Fo, M, Fi,
Citrus aurantium	Rutaceae	Fo, M, Fi
Cleome gynandra	Cleomaceae	Fo, M
Cleome viscosa	Cleomaceae	M
Cocos nucifera	Arecaceae	Fo, M, Fi, C, H, T
Cola cordifolia	Sterculiaceae	Fo, C
Colocasia esculenta	Araceae	Fo, M
Combretum mucronatum	Combretaceae	M
Cussonia arborea	Araliaceae	M, D
Cymbopogon citratus	Poaceae	M
Elaeis guineensis	Arecaceae	Fo, M, Fi, C, H, T, Cp, FH
Ficus sur	Moraceae	Fi
Flacourtia indica	Salicaceae	Fo, M
Flueggea virosa	Phyllanthaceae	M
Gymnanthemum coloratum	Asteraceae	M
Heliotropium indicum	Boraginaceae	M
Holarrhena floribunda	Apocynaceae	M, Fi, C, H, T
Hyptis suaveolens	Lamiaceae	H, Cp
Irvingia gabonensis	Irvingiaceae	Fo, Fi
Jatropha curcas	Euphorbiaceae	M, H
Jatropha gossypiifolia	Euphorbiaceae	M, T

(*Continued*)

Appendix Continued

Species	Family	Local use
Khaya senegalensis	Meliaceae	Fo, M, Fu, T, D
Lactuca inermis	Asteraceae	Fo, M
Lannea barteri	Anacardiaceae	M, Fi
Lannea nigritana	Anacardiaceae	M
Launaea taraxacifolia	Asteraceae	Fo, M
Lonchocarpus sericeus	Fabaceae	M, Fi, H, Cp
Mallotus oppositifolius	Euphorbiaceae	M
Mangifera indica	Anacardiaceae	Fo, M, Fi
Manihot esculenta	Euphorbiaceae	Fo, M
Milicia excelsa	Moraceae	M, Fi, C, H, T, FH
Mimosa quadrivalvis	Fabaceae	M
Momordica charantia	Cucurbitaceae	M
Morinda lucida	Rubiaceae	M, Fi, H
Moringa oleifera	Moringaceae	Fo, M
Nephrolepis biserrata	Lomariopsidaceae	M
Newbouldia laevis	Bignoniaceae	M, Fi, H, T
Ocimum americanum	Lamiaceae	M
Ocimum gratissimum	Lamiaceae	Fo, M
Parkia biglobosa	Fabaceae	Fo, M, Fi, T, C
Pergularia daemia	Apocynaceae	Fo, M
Phyllanthus muellerianus	Phyllanthaceae	M, Fi
Piliostigma thonningii	Fabaceae	M
Pouteria alnifolia	Sapotaceae	M
Psidium guajava	Myrtaceae	M, Fo, Fi, H
Pterocarpus erinaceus	Fabaceae	M, Fi, C, H, T
Pupalia lappacea	Amaranthaceae	M
Rauvolfia vomitoria	Apocynaceae	M
Rourea coccinea	Connaraceae	M
Sarcocephalus latifolius	Rubiaceae	M
Senna obtusifolia	Fabaceae	M
Senna occidentalis	Fabaceae	M
Senna siamea	Fabaceae	M, Fi, C, H
Sesamum radiatum	Pedaliaceae	M
Sida acuta	Malvaceae	M, D
Sida linifolia	Malvaceae	M
Strophanthus hispidus	Apocynaceae	M, Fi
Strychnos innocua	Loganiaceae	M, Fi, T
Talinum fruticosum	Talinaceae	Fo
Tectona grandis	Lamiaceae	M, Fi, C, H
Triclisia subcordata	Menispermaceae	M
Uapaca heudelotii	Phyllanthaceae	M
Uvaria chamae	Annonaceae	M, Fi
Vitex doniana	Lamiaceae	Fo, M

(*Continued*)

Appendix Continued

Species	Family	Local use
Xylopia aethiopica	Annonaceae	Fo, M
Zanthoxylum leprieurii	Rutaceae	M, Fi
Zanthoxylum zanthoxyloides	Rutaceae	Fo, Fi, C, Tr
Zingiber officinale	Zingiberaceae	Fo, M

Note. Use: Fo = food, Fi = firewood, M = medicinal, C = construction, H = household, Cp = crop protection (including agroforestry, soil water conservation, and bio-pesticides), T = traditions and ceremonies, FH = fishing and hunting.