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Diversity and prioritization of non timber forest products for economic valuation in Benin (West Africa)

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ABSTRACT

Species prioritization is a crucial step towards setting valuation strategy, especially for Non timber Forest Products (NTFP). This study aimed at assessing the diversity and ranking NTFPs for a successful economic valuation. Data were collected through literature review. Seven prioritization criteria were used in different prioritization systems. The top 50 NTFP species obtained by each system were identified and ten NTFP of highest priority occurring as priority across methods were selected. A total of 121 NTFPs belonging to 90 botanical genera and 38 botanical families were found. The top 10 priority were: *Vitellaria paradoxa, Parkia biglobosa, Adansonia digitata, Irvingia gabonensis, Blighia sapida, Tamarindus indica, Dialium guineense, Vitex doniana, Borassus aethiopum* and *Garcinia kola*. Due to the economic potential and the regional importance of these priority species, appropriate incentives for their valuation are needed and should be reflected in forest policies in Benin.

Key words: Biodiversity, non timber forest products, prioritization scheme, valuation

RÉSUMÉ

La priorisation des espèces constitue une étape cruciale dans toute stratégie de valorisation des produits forestiers non ligneux (PFNLs). Cette étude visait à évaluer la diversité et ressortir les PFNLs prioritaires pour une valorisation économique et leur intégration dans les chaines de produits agricoles. Les données ont été collectées à travers une synthèse bibliographique. Sept critères de priorisation ont été utilisés dans les différentes méthodes qui existent. Les 50 espèces les plus importantes ont été retenues par méthode et la confrontation des résultats des différentes méthodes a permis de retenir les 10 plus prioritaires pour la valorisation. Un total de 121 espèces appartenant à 90 genres et 121 familles a été obtenu. Les PFNLs les plus prioritaires étaient: *Vitellaria paradoxa, Parkia biglobosa, Adansonia digitata., Irvingia gabonensis., Blighia sapida, Tamarindus indica, Dialium guineense WiIld., Vitex doniana, Borassus aethiopum.* et *Garcinia kola*. Au regard du potentiel économique et de l'importance régionale de ces espèces prioritaires, des mesures incitatives appropriées doivent être prises pour leur valorisation et ces mesures devraient être reflétées dans les lois et textes régissant l'exploitation de ces ressources au Bénin.

Mots clés: Biodiversité, méthode de priorisation, produits forestiers non ligneux, valorisation

INTRODUCTION

According to diverse sources (Convention on Biological Diversity, 2002; Scotland and Wortley, 2003), about 270,000 plant species are known worldwide with some having nutritional potential (Kermali *et al.,* 1997). Nearly 30,000 plant species are edible and about 7,000 have been cultivated or harvested from the wild for food (Wilson, 1992). Those species are mostly known as Non Timber Forest Products (NTFPs).

The NTFPs play an important role in the livelihoods of local populations in West Africa (Heubach *et al.,* 2011). In addition, their socio-economic importance is unanimously recognized. According to the World Health Organization (WHO), several NTFPs play a crucial role in food security, nutrition, health and income generation of the rural poor in developing countries (Heubach *et al.*, 2011). Further the NTFPs are well adapted to their natural environment with high potential to cope in the event of climate changes. Most of NTFPs are gathered from the forest and some of them are gradually integrated in various agroforestry systems including home gardens and compound farms, forest gardens, parklands and trees on farmlands (Atta-Krah *et al.,* 2004).

According to FAO (2004), 1.6 billion people depend on forest resources for their livelihoods and 1.2 billion of them live in developing countries. For instance, baobab pulp (*Adansonia digitata* L.) is used as ingredient in various recipes (Sidibe and Williams, 2002; Chadare *et al.,* 2010). Zohoun *et al.* (2002) reported that the commercialization of four NTFPs generated roughly USD 4 million within a period of six months in 1998. Despite their proven importance, few NTFPs (e.g. *Adansonia digitata*, *Tamarindus indica*, *Vitellaria paradoxa*, and *Parkia biglobosa*) are economically valued in Benin and the majority of them are used for subsistence purpose. Unlocking the economic potential of the NTFPs in Benin cannot be optimally achieved without a sound identification and prioritization of NTFP species with high economic potential.

Successful strategies for NTFP management require use of a relevant approach which considers appropriate criteria for prioritization (Belcher and Schreckenberg, 2007). Also from economic point of view, as the best preferred may not always be the priority for valorization, N'Danikou *et al.* (2011) recommends use of scoring method for setting priority. A number of methods for setting species' priorities have been developed (Rabinowitz *et al.,* 1986; Coates and Atkins, 2001). Some methods set priority among wild edible plants based only on their elicited local value (N'Danikou *et al.,* 2011) while Brehm *et al.* (2010) set priorities among species using various criteria and different prioritization schemes. However, as there are not always available data for all criteria, results from these studies should be updated (UNEP, 1995) when more data are available.

The approach using the point scoring procedure (PSP), point scoring procedure with weighting (PSPW), compound ranking system (CRS) and binomial ranking system (BRS) is premised on the combination of four different methods comprising different criteria (Brehm *et al.,* 2010). This super classification scheme is robust enough to enable selection of the top priority species considering the long list of the criteria applied to each species. This replicable new methodology has already been applied by Idohou *et al.* (2013) for prioritizing Crop wild relatives in Benin.

The aim of the study was to assess the biological diversity and existing prioritization scheme that makes use of readily available data of each criterion in order to identify priority NTFPs species. A careful screening and prioritization of most potential species would help to inform long-term management plans and formulation of policy for the species valuation.

METHODS

Study area

The study was carried out in the Republic of Benin located between 6° and 12°50′ N and 1° and 3°40′ E in West Africa (Adomou *et al.,* 2010). Three biogeographical regions (Sudanian, Sudano-Guinean and Guineo-Congolian zones) were selected covering ten phytogeographical zones namely Atacora chain, Bassila, Coastal, Mekrou-Pendjari, North-Borgou, Plateau, Pobè, South-Borgou, Oueme valley and Zou (Figure 1). The vegetation is composed of semi-deciduous rain forest, swamp forest, gallery forest, dense dry forest, open forest, woodland savanna and tree and shrub savanna (Adomou *et al.,* 2010). The flora is estimated at 2807 species of plants divided into 1129 genera and 185 families (Akoègninou *et al.,* 2006). The most diversified families in terms of number of species are: Leguminosae (14.8 %), Poaceae (9.3 %), Rubiaceae and Cyperaceae (5 % each), Asteraceae (4.6 %) and Euphorbiaceae (4.3

%).

In the south of the country, the monthly mean temperature fluctuates between 26°C and 28°C while in the north monthly mean temperature ranges from 35°C to 40°C at Kandi (Adomou, 2005). Rainfall varies from 900 to 1400 mm per year. Rainfall distribution shows two types of patterns: tropical humid climate in the south (two rainfall maxima in April-July and September-October) and a Sudanian climate northwards with one maximum in June (Adomou, 2005).

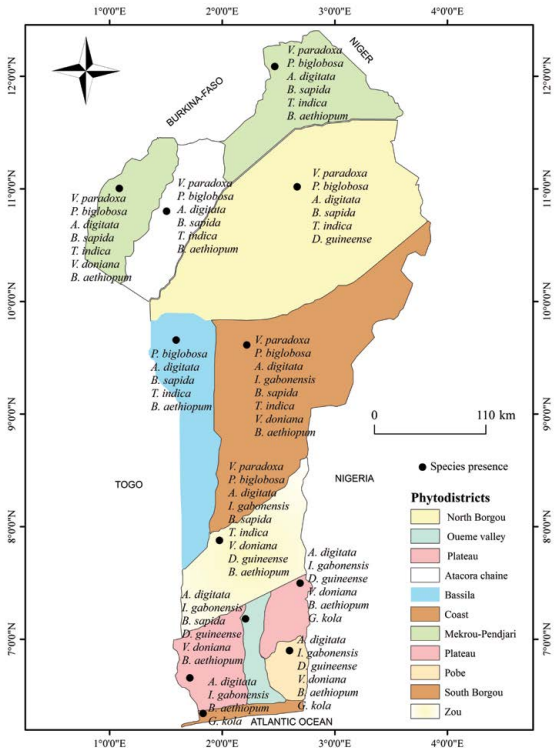

Fig. 1. Distribution of the ten priority NTFPs selected in the phytodistricts of Benin

Inventory of Non timber forest products across zones in Benin. Two approaches are commonly used to generate a national inventory of phytogenetic resources (Maxted *et al.,* 2009): numerical approach and manual approach. This study combined both approaches. For the manual approach, we reviewed BSc, MSc and PhD theses as well as reports in the libraries of all faculties whose research targets plants. This research was extended to ministries (Ministère de l'Agriculture, de l'Elevage et de la Pêche) and directions (Direction Générale des Forêts et Ressources Naturelles, Direction de l'Office National du bois) and other research institutions (Institut International d'Agriculture Tropicale – IITA, Centre de Recherche Agricole des Plantes Pérennes – CRAPP, Institut National des Recherches Agricoles du Benin – INRAB, Centre d'Agricole Régionale pour Développement Rural – CARDER, Office National d'Appui à la Sécurité Alimentaire - ONASA) whose actions also target plants. Libraries of International institutions such as FAO and UNDP were also visited. Our bibliographic search also used the numerical approach and we mainly employed PubMed and Google Scholar databases. The keywords used in search for documents included: Non-Timber Forests Products, NTFP(s), Non Wood Forest Products, Wild edible plants, Agroforestry species, Edible plants, and edible trees. Descriptive statistics, namely bar and pie charts were used to summarize information gathered. Analysis aims at identifying the national diversity of NTFPs species and how this diversity is distributed across the biogeographical zones.

Prioritization of Non timber forest products across zones for economic valuation. Establishing priorities among a diversity of species is an important step in any valuation strategy (Brehm *et al.,* 2010). The criteria used for the prioritization of NTFPs in this paper are adapted from Brehm *et al.* (2010) and Idohou *et al.* (2013). These criteria are as follows (See Figure 2): (i) Species status: Although the inventory conducted revealed the existence of native, introduced and unknown origin species, for this study priority were given to native (indigenous) species. (ii) Economic importance: The economic importance of non-timber forest products is used as a good indicator of their value. Thus four levels of importance were considered: local, regional, national and international. The priority was given to the species having higher economic importance. (iii) Ethnobotanical uses: This was assessed through existing local knowledge on the uses of NTFP species. Priority was given to the species reported as having a high ethnobotanical value for local communities. (iv) Level of distribution: Priority increases with larger distribution, therefore, nationally- or regionally- restricted species (or endemics) were given less priority compared to species occurring worldwide. Moreover, priority was given to NTFP species occurring throughout the country (most phytochorological areas) compared to those occurring in a few regions. (v) Valuation status: The existence of tools or techniques for the valuation of NTFPs was considered important in setting priorities among species with regard to their valuation status. Hence, priority was given to species already in use or

at least locally or processed compared to those not in uses. (vi) Legal status: Priority was given to NTFP species not covered by existing national policies or legislation aimed at ensuring their sustainable use. (vii) Threat status: Priority was given to NTFP species that are less threatened (The IUCN Red List of Threatened Species. Version 2014.3). Four methods combining the above criteria were adapted from Brehm *et al.* (2010) and Idohou *et al.* (2013): point scoring procedure (PSP), point scoring procedure with weighting (PSPW), compound ranking system (CRS), and binomial ranking system (BRS).

In the PSP, a series of scores for multiple criteria was assigned to each species, with the highest number indicating the highest priority. The overall score for each CWR was obtained by the sum of all individual criteria: (species status + valuation status + ethnobotanical use + distribution level + threats status + legal status) Therefore, higher scores indicate greater conservation concern. The PSPW is similar to the PSP with the difference that a particular weight is given to each criterion. The CRS uses individual criteria ranking positions (not scores as in PSP), which are then combined in order to obtain a compound rank for each species and for each major criterion. The BRS is based on a series of Yes/No questions. A ‘‘Yes’’ being a higher priority than a ‘‘No’’. The top 50 species were obtained for each method: PSP, PSPW, CRS, BRS and the number of times each top 50 species occurred in the different sub lists was recorded. The highest priority species were those that occurred most commonly in individual lists (see Brehm *et al.,* 2010). Finally, the ten most represented NTFPs and occurring as priority across the four methods were selected.

RESULTS

Diversity of Non timber Forest Products in Benin. A total of 121 NTFPs belonging to 90 botanical genera and 38 botanical families were found. Seventy seven were recorded for the Guineo-Congolean zone, sixty nine for the Sudano-Guinean zone and sixty one for the Sudanian zone. Figure 3 shows the number of exclusive species and overlap across biogeographical zones. Thirty species were exclusive to the Sudanian zone while approximately one third (11) of this number was found as exclusive to the Sudano-Guinean zone, 21 species being exclusive to the Guineo-Congolean zone. Twenty eight species were exclusive to both Guineo-Congolean and Sudano-Guinean zones while only three and one species were exclusively found in Sudano-Guinean and Sudanian zones and Guineo-Congolean and Sudanian zones, respectively. Twenty seven species were common to all three

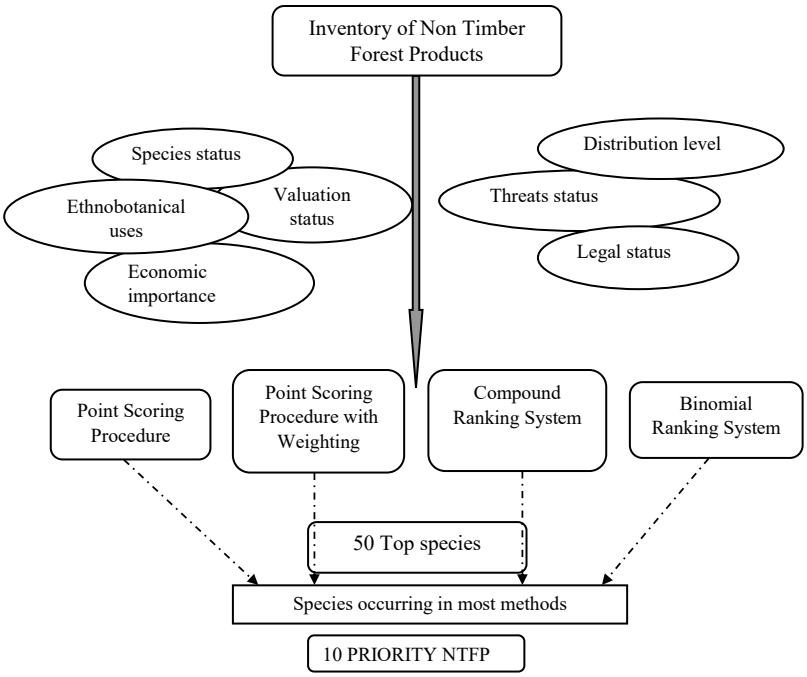

Fig. 2: Methodology used for setting priorities for economic valuation of NTFPs in Benin [Adapted from Brehm *et al.* (2010) and Idohou *et al*. (2013)].

biogeographical zones.

Figure 4 shows the number of species per botanical family. The most diversified family were respectively Moraceae (11 species), Anacardiaceae (8 species), Annonaceae (7 species), Rubiaceae (7 species), Leguminosae - Caesalpinioideae (6 species). Leguminosae family turned out to be most diversified (Figure 4).

Non Timber Forest Products priority setting for valuation using Point Scoring Procedure method. The PSP method found that the most represented NTFPs families and number of species were: Meliaceae (5 species), Leguminosae-Caesalpinioidae (4 species), Anacardiaceae (3 species), Annonaceae (3 species) and Sapotaceae (3 species). Species in the Cola-genus were more represented (4 species: namely *Cola acuminata* (P. Beauv.) Sehott and EndI., *C. gigantea* A. Chev. var. *gigantea*, *C. nitida* (Vent.) Sebott and EndI. and *C. millenii* K. Schum.) followed by *Aframomum* genus [2 species; *Aframomum alboviolaceum* (RidIey) K. Schum. and *A. sceptrum* (Olïv. and D.Ranb.) K. Schuman (Figure 5A].

Non Timber Forest Products priority setting for valuation using Point Scoring Procedure with weighting method. The point scoring procedure with weighting (PSPW) identified 50 priority NTFPs species for valuation and the most represented families and number of species were: Moraceae (5 species), Meliaceae (4 species), Leguminosae-Caesalpinioideae (4 species), Annonaceae (4 species) and Sapotaceae (4 species; Figure 5B). Ficus (with 4 species namely: *Ficus dicranostyla* Mildbr., *Ficus lutea* Vahl, *Ficus platyphylla* Del. and *Ficus umbellata* Vahl) and Cola (with 3 species namely C. acuminata, C. gigantea and C. nitida) were the most represented genera.

Non Timber Forest Products priority setting for valuation using Compound Ranking System. CRS method identified 50 priority NTFP species for valuation and the most represented families and number of species were: Annonaceae (5 species), Leguminosae-Caesalpinioideae (4 species), Meliaceae (4 species), Spindaceae (4 species) and Sapotaceae (3 species; Figure 5C). The most represented species were encountered in the genus Cola (with 3 species), Annona (*Annona muricata* L. and *Annona senegalensis* Pers.) and Detarium (*Detarium microcarpum* Guill. and Perr. Detarium senegalense J. F. Gmel.) both with two species.

Non Timber Forest Products priority setting for valuation using binomial ranking system. The BRS method identified 50 priority NTFP species for valuation and the most represented families and number of species were: Meliaceae (6 species), Leguminosae-Caesalpinioideae (4species), Sapotaceae (4 species), Verbenaceae (3 species)

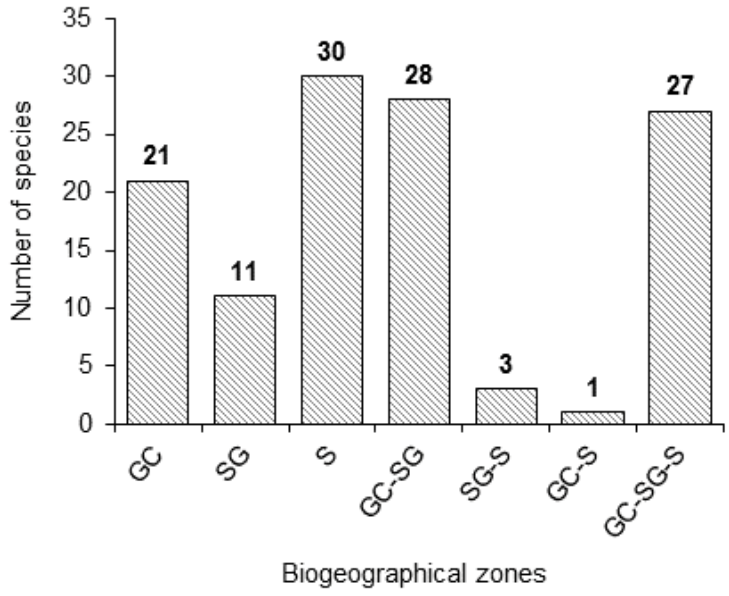

Fig. 3 Diversity of NTFP species across the three biogeographical zones: exclusive diversity and overlap. GC= Guineo-Congolean zone, SG= Soudano-Guinean zone, S= Sudanian zone.

and Arecaceae (3 species; Figure 5D). The most represented species were found in the genus Cola with 5 species (*C. acuminata*, *C. gigantea, C. laurifolia, C.millenii* and *C. nitida*).

Priority Non Timber Forest Products identified for valuation resulting from crossing reporting of the four abovementioned methods. Each of these previously applied methods (PSP, PSPW, CRS and BRS) provided a list of species ordered by importance. The number of times each top 50 species occurred in the different sub lists was recorded and the top 10 priority species (occurring on the list of all methods) were: *Vitellaria paradoxa, Parkia biglobosa, Adansonia digitata, Irvingia gabonensis, Blighia sapida, Tamarindus indica, Dialium guineense, Vitex doniana, Borassus aethiopum* and *Garcinia kola* (Table 1).

The analysis revealed that these 10 priority NTFP species had multiple uses with high economic potential (Table 2) and were currently valued at least at regional level and rated with high economic importance. With the exception of three species (*Garcinia kola, Irvingia gabonensis* and *Vitellaria paradoxa*), the rest of the NTFPs species selected by this approach do not have any assessed threat status (Table 2). Most of the species have broad distribution (Figure 1) and could be good candidate for economic valuation.

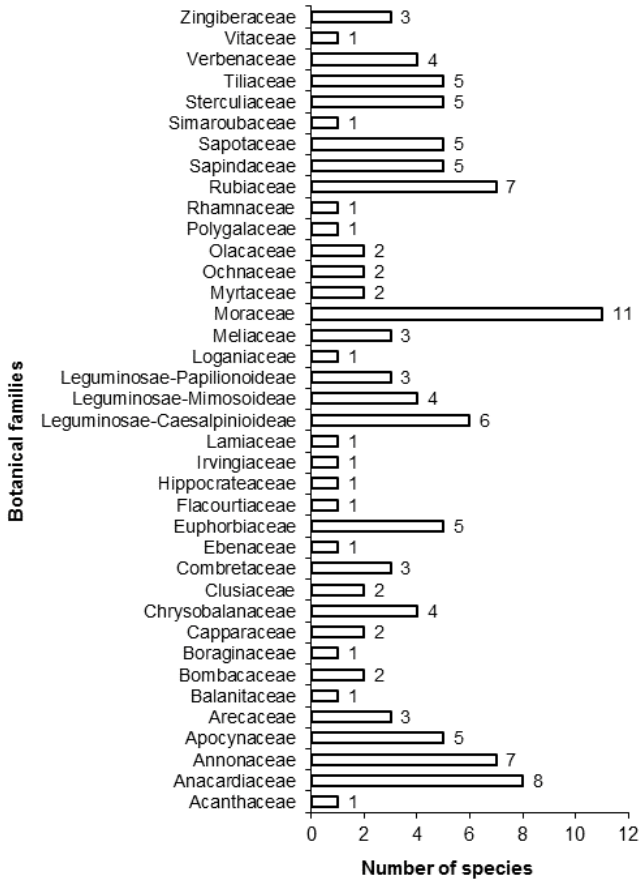

Fig. 4 Diversity of NTFP species within botanical family

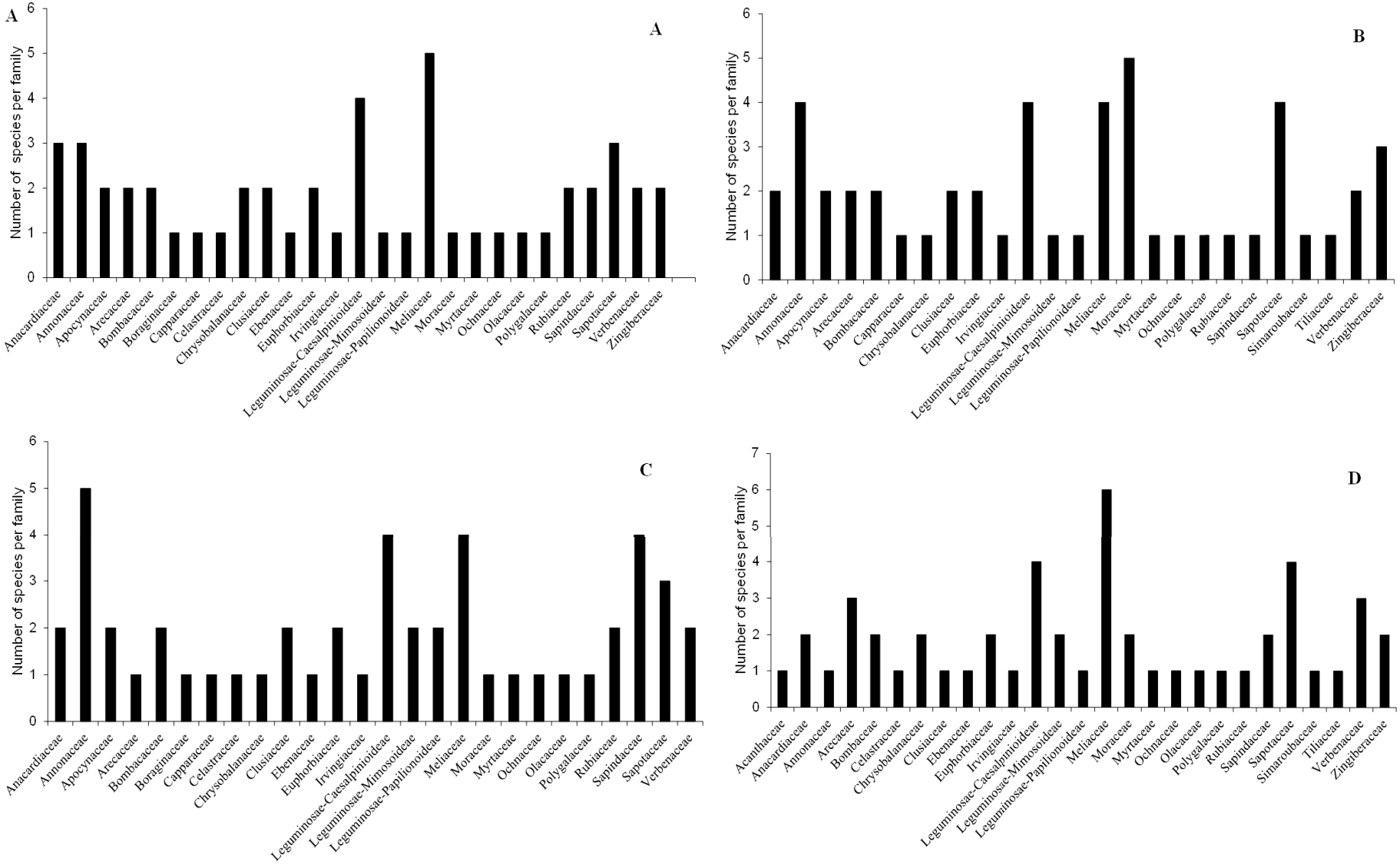

Fig. 5 Distribution of priority NTFP species per botanical family using (A) point scoring procedure method, (B) point scoring procedure with weighting method. (C) compound ranking system and (D) binomial ranking system.

DISCUSSION

The number of species recorded i.e., 121 is about three times higher than the number (43) of species recorded in agroforestry systems by Assogbadjo *et al.* (2012). The present result emphasizes the fact that substantial part of the observed diversity is still being harvested from forest although an interesting part is already found in agroforestry systems. The result is also indicative of the few conservation efforts which are made towards integration of these species in formal agricultural systems. The observed decrease of the diversity with drought is consistent with the hypothesis that diversity tends to decline with increasing altitude (Schall and Pianka, 1978) and also with declining precipitation (Brown and Davidson, 1977). Other studies however found different trends including Salako *et al*. (2014) for diversity of species in home gardens and Achigan-Dako *et al*. (2011) for diversity of traditional vegetables. Such differences may be linked to the fact that we did not include all life forms as (we did disregards herbs), and suggest that the trend of diversity in relation to drought may vary with life forms considered. The observed highest exclusive species in humid and arid zones and highest number of shared species between humid and semi-arid

Table 1. Ten non timber forest products identified for economic valuation in Benin

		Prioritization methods			
Family	Species	PSP	PSPW	CRS	BRS
Sapotaceae	*Vitellaria paradoxa*	x	x	x	x
Leguminosae-Mimosoideae	*Parkia biglobosa*	x	x	x	x
Bombacaceae	*Adansonia digitata*	x	x	x	x
Irvingiaceae	*Irvingia gabonensis*	x	x	x	x
Sapindaceae	*Blighia sapida*	x	x	x	x
Leguminosae-Caesalpinioideae	*Tamarindus indica*	x	x	x	x
Leguminosae-Caesalpinioideae	*Dialium guineense*	x	x	x	x
Verbenaceae	*Vitex doniana*	x	x	x	x
Arecaceae	*Borassus aethiopum*	x	x	x	x
Clusiaceae	*Garcinia kola*	x	x	x	x

PSP: Point Scoring Procedure; PSPW: Point Scoring Procedure with Weighting; CRS: Compound ranking System; BRS: Binomial ranking System

Table 2: Information on ethnobotanical uses, economic importance, and level of valuation of the ten priority non timber forest products for valuation in Benin

Taxa	Ethnobotanical uses	Economic importance	Level of valuation	Threats assessment (www.iucnrelist.org)
Vitellaria paradoxa	Food,medicines, craft,	International	International	VU
Parkia biglobosa	Food, medicines, craft, construction, fodder	International	Regional	NE
Adansonia digitata	Food, medicines, socio-cultural	International	International	NE
Irvingia gabonensis	Food, medicines, socio-cultural	Regional	Regional	NT
Blighia sapida	Food, medicines, socio-cultural	International	International	NE
Tamarindus indica	Food, medicines, craft, socio-cultural	International	International	NE
Dialium guineense	Food, medicines, socio-cultural	Regional	Regional	NE
Vitex doniana	Food, medicines, socio-cultural	Regional	Regional	NE
Borassus aethiopum	Food, medicines, craft, construction, socio-cultural	Regional	Regional	NE
Garcinia kola	Food, medicines, socio-cultural	Regional	Regional	VU

VU: Vulnerable, NE: Not Evaluated, NT: Near Threatened

zones is likely the result of species requirements for ecological conditions.

Sustainable valuation of economically important non timber forest products requires identification of priority species for more effective actions. This could help to reduce the increasing pressure on the species in their distributional areas as those species often targeted by local people are most of the time overexploited due to their large usefulness (food, medicinal, crafts, fodder, fuel, etc) (Vodouhê *et al.,* 2009). Such threat, in addition to the lack of regenerations of NTFPs in traditional agricultural systems, put most of NTFPs used at high risks. Definition of priority could also help to ensure their sustainable and long-lasting use. Indeed, previous studies have revealed the consensual role that Non timber Forest Products play in daily life of local people and in income generation for farm households around forest and agroforestry systems (Debabrata and Sundriyal, 2010). Indeed, the NTFP contribute to gross domestic product of many countries (FAO, 2001) and could help to improve livelihoods of local people especially in agricultural areas (Saha, 2009; Debabrata and Sundriyal, 2010).

Although most of the currently identified priority NTFPs are already valued in other countries such as RDC, Congo, Central Africa Republic, Gabon and Cameroon (Tchatat and Ndoye, 2006), their economic valuation in Benin is still not optimal. As such, there is an urgent need to propose a valuation strategy to increase the capacity of those species to contribute to local economy and human welfare.

Several methods have been proposed to bring out priority species. In the framework of the current research we used the most recent approach proposed by Brehm *et al.* (2010) and successfully applied by Idohou *et al.* (2013) in a study targeting priority crop wild relatives for conservation actions and in assessing conservation priorities of fodder trees in the Sudano-Guinean pasture lands of Benin (Sewadé *et al.,* 2016). Indeed, this approach used in this study is very flexible and allows for combination of several criteria to fulfill the objectives of the study. The approach developed in this paper differs from the one used by Maraseni (2008), Vodouhê *et al.* (2009), and Debabrata and Sundriyal (2010) to identify the most important Non-Timber Forest Products in Northeast India, Nepal, and northern Benin, respectively. N'Danikou *et al.* (2011) used an independent scoring of species in value and conservation criteria developed by the community. These authors argued that successful management strategies will then need to consider the criteria that communities use in their species valuation, as strategies that operate exclusively with market-based criteria are likely to overlook communities' interests.

In this study apart from the economic and ethnobotanical uses of the NTFP species targeted, some other criteria regarding the conservation (legal status, threat status) and the ecology (level of distribution) were considered. By doing so the conservation and valuation goals of the NTFPs were considered simultaneously and could help for sustainable management of the resources. Moreover, sustainable utilization of the NTFPs would need to take into account combination of objectives such as the species use for subsistence, ecology and conservation.

CONCLUSION

This study has revealed the diversity of NTFPs across biogeographical zones in Benin and demonstrated the use of a combination of methods to prioritize NTFP species for valuation. The ten top species are *Vitellaria paradoxa, Parkia biglobosa, Adansonia digitata, Irvingia gabonensis, Blighia sapida, Tamarindus indica, Dialium guineense, Vitex doniana, Borassus aethiopum* and *Garcinia kola* which are important for subsistence and economic purposes in the rural areas of Benin. There is a need for valuation of these underutilized NTFP species in terms of their contribution to poverty alleviation in Benin.

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STATEMENT OF NO CONFLICT OF INTEREST

We the authors of this paper hereby declare that there are no competing interests in this publication.

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