



Ethnobotanical research of tree species used in wood carving in Southern Benin: Perspective for sustainable forest conservation

Hubert O. Dossou-Yovo, Valentin Kindomihou and Brice Sinsin

Research

Abstract

Background: This research aimed at assessing the diversity of timber species used in wood carving in southern Benin, identify various sources of wood as well as most species used. We also stated that wood is recorded as the most used part for carving. The scarcity or availability of species with quality wood and their causes in recent years were assessed. Carvers' willingness to contribute to species conservation was also documented. With a perspective of sustainable forest conservation, the impact of wood carving activity on forests was also assessed.

Methods: A preliminary survey was conducted to determine the number of wood carvers in three districts of Southern Benin. A semi-structured questionnaire was used to collect data from twelve wood carvers. Data was analyzed through descriptive statistics, mainly using percentages and mean. We determined the Use Value of the most used species for woods in order to assess their relative importance.

Results: Twenty-two species were used in wood carving with most species having red or yellow wood. The purchase of wood in industrial markets was the predominant source, followed by the direct purchase from plantation and tree owners. Among the main woody species used including *Diospyros mespiliformis*, *Chlorophora excelsa*, *Tectona grandis* and *Gmelina arborea*, the Use Value (i.e. relative importance in terms of diversity of uses) was the highest with *G. arborea* and *C. excelsa*. While most of carvers mainly accused logging of making wood

scarce and destroying forests and plantations, only a minority (25%) own *G. arborea* and *A. auriculiformis* plantations.

Correspondence

Hubert O. Dossou-Yovo^{*}, Valentin Kindomihou, Brice Sinsin

Laboratory of Applied Ecology, Faculty of Agronomic Sciences, University of Abomey-Calavi, Benin

^{*}Corresponding Author: dohuoly@yahoo.fr

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Carvers indicated their willingness to have plantations of *T. grandis* and *G. arborea* for personal use and trade.

Promoting reforestation and timber species plantation are plausible through integrated policies, such as:

- (i). Developing appropriate silviculture;
- (ii). Sensitizing actors about forest conservation, the need for appropriate silviculture by giving priority to the quality of products and techniques at all stages;
- (iii). Strengthening forestry services capacities, consolidating technical achievements and monitoring forestry actions;
- (iv). Establishing, consolidating and developing sustainable self-promotion capacities of rural populations mainly women's groups, based on the integrated land development, beneficiaries' entrepreneurial participation and the

commercialization chain promotion at community and regional scales

(v). Creating and supporting institutional structures in monitoring learning;

(vi). Promoting the advent of self-managed rural forestry based on the principle that reforestation really develops whether it can generate its own resources.

Conclusions: A diverse range of tree species are used in carving in Southern Benin. The most used species were *D. mespiliiformis*, *C. excelsa*, *T. grandis* and *G. arborea*. *Gmelina arborea* and *C. excelsa* had the highest Use Value. Carvers indicated their willingness to contribute to species plantation and conservation. Wood carving had an impact on forest and thus a need to promote reforestation and plantation, and to raise awareness with wood carvers on sustainable resource utilization and management.

Key words: Fragmentation; Plantations; Reforestation; Use Value; Wood Carving

Background

Forests play a key role in people's life and are of inestimable value (Jones *et al.* 2016, Ritter & Dauksta 2013). Forests are vital natural resources (WWF 2020) and crucial for the achievement of the Sustainable Development Goals (SDGs) (Simeons 2018). Forests and their derivative timber and non-timber products have been used by societies around the world for thousands of years (Ramage *et al.* 2017). Moreover, forests provide ecological services, contributing significantly to environmental stability (Simeons 2018). Forests are also a treasury of medicinal plants and pharmaceutical ingredients (Dossou-Yovo *et al.* 2014, 2017). Wood harvested from natural forests and plantations is used for fuel, construction, and craft such as carving (Smith *et al.* 1993). Although timber and non-timber forest products remain an important source of livelihoods in large parts of the world, especially in Africa, their extraction is also a major driver of deforestation (UCS 2016).

Wood carving has been a common cultural practice of civilizations throughout the ages. For instance, samples of wooden arts by the ancient Egyptians, Greeks, Romans and Chinese still exist (Wikipedia). Wood carving plays a great role in the cultural identity of countries. In Benin, wood carving has been practiced since time immemorial and many ancient wooden artifacts have been preserved, including many that explain the key role played by the country during the slavery period. Despite the cultural and historic importance of wood carving in Benin, little research has been conducted on this activity, although many people today still depend on

wood carving for their livelihoods (Okrah 2002; Appiah-Kubi *et al.* 2014, Kayode *et al.* 2016). As a result, much attention should be focused on this practice so as to ensure sustainable and improved livelihoods for wood carvers and their families. To achieve this, natural and planted forests from which wood is harvested for carving should be well managed and conserved. The aim of this paper was to report the diversity of timber species used in wood carving in Benin, the sources of wood used, and the relative importance of the most commonly used woods. From the perspective of sustainable forest conservation, the availability of wood to carvers and their willingness to contribute to species conservation were assessed. It was expected that the results of this study would enable forestry advisers and political leaders to better organize wood carving throughout the country.

Materials and methods

Prior to data collection, a preliminary survey was conducted to record the total number of wood carvers in three districts of Benin; which are Ouidah, Abomey-Calavi and Cotonou. There were five wood carvers in Ouidah, two in Abomey-Calavi and five in Cotonou. The later were based at the Benin art promotion center. These twelve wood carvers were interviewed using a semi-structured questionnaire to gather knowledge on the diversity of woods they used, their sources of wood, the ranking of the most used woods, and categories of art made with each wood. The availability of wood in recent years as well carvers' willingness to contribute to timber species conservation were also investigated. We recorded local names of tree species, their scientific names follow de Souza (1988) and Arbonnier (2002). Direct observations of the woods that carvers used, and the products were also made. In order to access the relative importance of the four most used woods, their Use Value (Zenderland *et al.* 2019) was calculated by dividing the number of uses for the concerned wood by the number of carvers who mentioned the wood as most used. Percentages of carvers were determined for various items in order to assess the diversity of ethnobotanical knowledge related to wood carving. A percentage was obtained by dividing the number of citations for the concerned item by the total number of carvers surveyed. Carvers were also asked to free list the causes of wood scarcity or abundance in the recent years.

Results

Diversity of woody species used in carving

The wood of 22 species, belonging to 22 genera and 15 families, were reported to be used in carving. The most represented family was the Caesalpiniaceae, represented by one species in each of three genera,

Afzelia africana, *Delonix regia* and *Daniellia oliveri* (Table 1). The families Moraceae, Meliaceae, Verbenaceae, Mimosaceae and Anacardiaceae were each represented by two species, and there was one species in each of the remaining nine families. The wood used in carving exhibited a range of colors according to the respondents (Table 1). Four major

colors were recorded, yellow (seven species including two described as clear yellow and yellow brown, respectively), red (seven species), white (six species including one described as ash) and black (two species).

Table 1. Woody species used in carving and wood colour as described by wood carvers.

Scientific name	Local name in Fon	Botanical family	Wood colour
<i>Acacia auriculiformis</i> A. Cunn. ex Benth.	Acacia	Mimosaceae	Black
<i>Afzelia africana</i> Sm. & Pers.	Abzélia	Caesalpiniaceae	Red
<i>Artocarpus communis</i> J. R. Forst. & G. Forst.	Blêfoutoutin	Moraceae	Yellow
<i>Azadirachta indica</i> A. Juss.	Kininetin	Meliaceae	Red
<i>Chlorophora excelsa</i> (Welw.) C. C. Berg	Lokotin	Moraceae	Yellow brown
<i>Cocos nucifera</i> L.	Agonkêtin	Arecaceae	Red
<i>Daniellia oliveri</i> (Rolfe) Hutch. & Dalziel	Zatin	Caesalpinaceae	Red
<i>Delonix regia</i> (Bojer ex Hook.) Raf.	Fontin	Caesalpinaceae	Ash
<i>Diospyros mespiliformis</i> Hochst. ex A. DC.	Ebène	Ebenaceae	Black
<i>Eucalyptus camaldulensis</i> Dehnh.	Ecalitus	Myrtaceae	Clear yellow
<i>Gardenia erubescens</i> Stapf & Hutch.	Dakplatin	Rubiaceae	Yellow
<i>Gmelina arborea</i> Roxb. ex Sm.	Mélina	Verbenaceae	White
<i>Khaya senegalensis</i> (Desr.) A. Juss.	Zounza	Meliaceae	Red
<i>Mangifera indica</i> L.	Amangatin	Anacardiaceae	White
<i>Newbouldia laevis</i> (P. Beauv.) Seem.	Désrêguêtin	Bignoniaceae	White
<i>Prosopis africana</i> (Gull. & Perr.) Taub.	Kakêtin	Mimosaceae	Red
<i>Pterocarpus erinaceus</i> Poir.	Kosso	Papilionaceae	Yellow
<i>Rauvolfia vomitoria</i> Afzel.	Atêtin	Apocynaceae	White
<i>Spondias monbin</i> L.	Akinkontin	Anacardiaceae	White
<i>Tectona grandis</i> L. f	Têkitin	Verbenaceae	Yellow
<i>Terminalia catappa</i> L.	Kolatin	Combretaceae	Red
<i>Zanthoxylum zanthoxyloides</i> (Lam.) Zepern. & Timler	Hêtin	Rutaceae	Yellow

Sources of wood used in carving

Carvers reported four sources of wood used in carving. These were wood provided by customers themselves, wood bought by carvers in industrial or local informal markets, wood purchased by carvers from owners of plantations or individual trees, and the harvest of wood from carvers' own plantations. The predominant source recorded was the purchase of wood in industrial wood markets (75% of respondents), followed by the direct purchase from plantation or tree owners (58% of respondents), the provision of wood by customers themselves (58% of respondents), and collection of wood from carvers' plantations (25% of respondents). It is important to highlight the low proportion of carvers who harvest wood from their own plantations.

Ranking of woods used for carving

Fifty percent of respondents reported wood of *Diospyros mespiliformis* (locally called *ébène* in Fon; black wood) as the most used for carving, while 42%

mentioned the wood of *Chlorophora excelsa* (locally called *lokotin*; yellow brown wood) as the most used (Table 2). Wood of *Tectona grandis* (*têkitin* in Fon; yellow wood) ranked third in this paper because it was mentioned by 50% of respondents as second most used. The fourth most used wood was *Gmelina arborea* (*mélina* or *fôfitin* in Fon; white wood). Regarding the sources of the most used woods, all informants mentioned the purchase of *D. mespiliformis* wood in industrial wood markets, wood coming from northern Benin. Some informants (25%) reported the purchase of the wood of *C. excelsa* from tree owners and 17% of them insisted on its provision by customers themselves. Informants who mentioned *T. grandis* and *G. arborea* confirmed that they mostly purchased wood from tree and plantation owners as well as local informal markets.

The Use Value of the most used woods

In terms of utilization, the woods of *D. mespiliformis*, *C. excelsa*, *T. grandis* and *G. arborea* were all used

for small and large ornamental arts (See Fig. 1, 2 and 3 as examples of recorded arts). Additionally, the wood of *C. excelsa* was used to carve spiritual objects, and the woods of *T. grandis* and *G. arborea* were used to make table utensils. Among the most commonly used species, *C. excelsa* exhibited a

relatively greater importance than *D. mespiliformis* as shown by the Use Value (Table 3). Although the wood of *G. arborea* was the fourth most commonly used, it had the highest Use Value while wood of *D. mespiliformis* had the lowest Use Value.

Table 2. Ranking of the species most used in carving

Species	Percentage of respondents ranking the species (%)	
	Most used	Second most used
<i>Diospyros mespiliformis</i> Hochst. ex A.DC.	50	0
<i>Chlorophora excelsa</i> (Welw.) C. C. Berg.	42	0
<i>Tectona grandis</i> L.	0	50
<i>Khaya senegalensis</i> (Desr.) A. Juss.	8	8
<i>Gmelina arborea</i> Roxb. ex Sm.	0	17
<i>Acacia auriculiformis</i> A. Cunn. ex Benth.	0	8
<i>Daniellia oliveri</i> (Rolfe) Hutch. & Dalziel	0	8
<i>Azelia africana</i> Sm. & Pers.	0	9

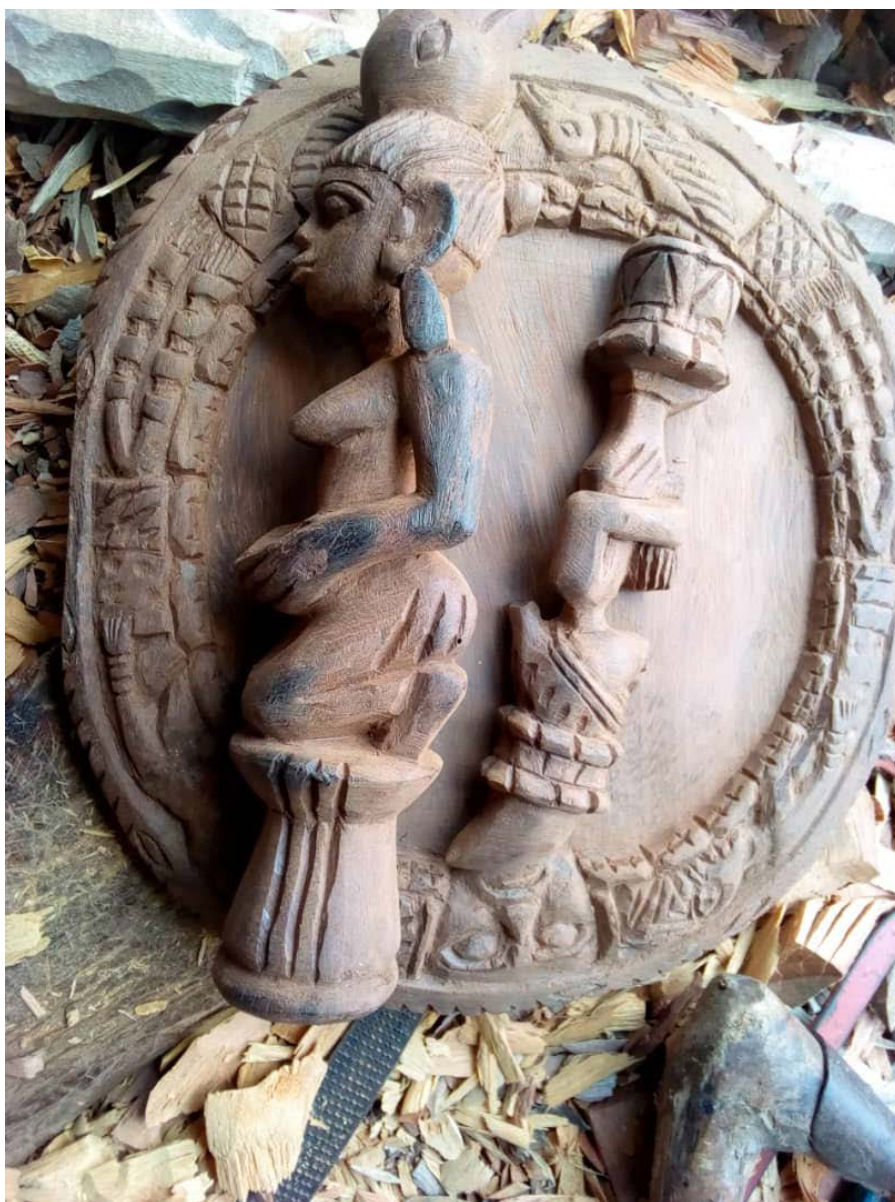


Figure 1. Ornamental art made from the wood of *Chlorophora excelsa*



Figure 2. Wood of *Terminalia catappa* carved to make ornamental art.

Table 3. Use Value of the four woods most used in carving.

Wood species	Number of uses	Number of informants mentioning a species	Use Value
<i>Diospyros mespiliformis</i> Hochst. ex A.DC.	2	6	0.33
<i>Chlorophora excelsa</i> (Welw.) C. C. Berg.	4	5	0.80
<i>Tectona grandis</i> L.	3	6	0.50
<i>Gmelina arborea</i> Roxb. ex Sm.	3	2	1.50



Figure 3. Ornamental art made from the wood of *Diospyros mespiliformis*

Availability of woods according to carvers

All informants reported the scarcity of woods for carving in recent years. They also highlighted that wood has consequently become very expensive. With regards to the causes of this scarcity, six reasons were reported (Table 4). The most frequently mentioned cause of scarcity was the destruction of forests and other plantations by the local populations. The international trade of wood as well as political restrictions towards local trade of wood ranked second in the same proportion followed

the exploitation of wood for charcoal production, population growth and lack of plantation expansion.

Willingness to contribute to recorded species conservation

Only 25% of wood carvers owned plantations of *Gmelina arborea* and *Acacia auriculiformis*, with an average area of 2.5 ha. All informants were interested in investing in woody species plantations if they had more money. Fifty percent of carvers reported that they would plant *G. arborea* while 42%

would prefer to plant *T. grandis* plantations from which they could harvest woods for carving.

Table 4. Causes of wood scarcity in recent years according to carvers

Cause	Percentage of informants (%)
Destructions of forests and plantations for logging	58
International trade of wood	17
Political restrictions on local trade	17
Wood exploitation for charcoal production	8
Lack of plantations	8
Lack of plantations	8

Discussion

Diversity of woody species used in carving

Twenty-three plant species were recorded as used in carving confirming that wood carvers have an extensive knowledge about the quality of woods and their utilization. The range of species used suggests that their exploitation can increase environmental pressure, contributing to forest fragmentation and local species loss all over the country. Trees are, most of the time, uprooted for wood collection and, although wood carving provides an income to workers, it constitutes a threat to species conservation. Wood carving was reported as a threat to forest diversity in Ghana because of exploitation of endangered species (Okrah 2002). Kayode *et al.* (2016) recorded 39 plant species belonging to 23 families used in carving in Nigeria. Similarly, the wood carving industry in Kenya is highly dependent on indigenous tree species (Mutinda 2014).

Types of woods recorded

The diversity of type of wood used confirms that the choice depends on items to be carved (Kayode *et al.* 2016). Woods, in addition to their color also vary from soft to hard, and this influences the items for which they are used. A relatively high number of species was recorded as giving red wood followed by species having yellow wood. This confirms the various attractive aspects searched for in wood by carvers and the assertion that the components of art include color, patterns and the reproduction of visual likeness (Morris-Kay 2010).

Sources of recorded woody species

The purchase of wood in industrial markets was recorded as the main source for carvers followed by direct purchase from plantation and tree owners. A very low proportion of carvers owned their

plantations from which woods may be collected. These aspects confirm that harvesting of wood for carving threatens the conservation of forests throughout Benin. The majority of wood traded in industrial markets comes from the central and northern parts of the country. So, natural forests and sometimes plantations are cut down to satisfy a growing demand for wood. Even customers who provided their own woods for carving are destroying individual trees that are expected to protect the environment. No informant mentioned the purchase of wood from public plantations meaning a lack of public forestry areas, plantations or agroforestry parks, wherein carvers could get woods whenever they want, provided they are able to afford its cost.

Ranking of woods used for carving

Diospyros mespiliformis ranked as the most used wood and informants who selected it were mostly those working in Cotonou. Carvers insisted that this wood is the most appreciated by tourists. The black colour may attract people and it is easy to sell art made with this wood even if the customers are local. Carvers using this wood targeted the international market by exporting their arts. The genus *Diospyros* is widely recognized for its black wood. Furthermore, informants highlighted its durability, hardness and ability to take a high polish. The collection of *D. mespiliformis* wood from natural forests to satisfy the increasing demand is clearly a threat to the species conservation. *Chlorophora excelsa* is widely used in Benin as its wood serves to make sacred objects in addition to ornamental art. Similar to the present findings, Okonkwo *et al.* (2016) reported the use of *C. excelsa* (Iroko) in carving sacred objects in Nigeria. In addition to the exploitation of this species in carving, it is widely used in carpentry and as medicine in Benin (Ouinsavi *et al.* 2005). Several years ago, the pressure placed on populations of *C. excelsa* of its exploitation in Benin was stated (Sokpon *et al.* 2003) and its exploitation in carving no doubt increases its extinction rate. Alternatives should be found to help carvers maintain their livelihoods without compromising the sustainability of the species. *Tectona grandis* and *Gmelina arborea* are two plantation species that have been grown in Benin for decades. They were recorded among the most used in carving. Similar to the present findings, has also been reported in wood carving in Ghana (Appiah-Kubi *et al.* 2014). *Tectona grandis* and *G. arborea* woods were purchased from tree and plantation owners which confirm a high pressure on these species as they are also highly demanded for carpentry throughout the country. Carvers justified the use of *G. arborea* wood by the fact that its white color gave an attractive aspect for arts. In addition, they argued that woods of *G. arborea* and *T. grandis* are sometimes more available than other woods.

Similarly, *G. arborea* and *T. grandis* were mostly preferred for wood carving in India (Sharma et al. 2013). *Tectona grandis* has been identified as the species with most potential for the establishment of high-quality tropical hardwood plantations under sustainable forest management (Thulasidas & Baillères 2017)

The Use Value of the most used woods

The results confirmed that the frequency of use of a species wood can sometimes contrast with its relative importance. *Gmelina arborea* and *C. excelsa* both had greater Use Value than *D. mespiliiformis* despite the more frequent use of this species. These findings confirmed the importance of the Use Value to assess the relative importance of plant species in ethnobotanical studies.

Availability of woods according to carvers

The scarcity of woods recorded in this research confirmed the high environmental pressure placed on tree species used in carving. Forests are fragmented to satisfy wood demands for carving and many other purposes. This has negative impacts on biodiversity conservation all over the country. Reforestation programs taking into account woody species used in carving are necessary throughout the country. Priority species can be *C. excelsa* and *D. mespiliiformis*. As *T. grandis* and *G. arborea* have already been grown in plantations throughout the country for many decades, leaders are encouraged to promote these species in plantations. It has been stated that in Benin, farmers specialized in pole-wood production to supply urban demand for cheap construction timber (Aoudji et al. 2014). Large individual trees of *T. grandis* and *G. arborea* are needed to ensure a long-term wood carving activity in Benin because arts made by carvers play a great role in tourism and in the cultural identity of the country.

Willingness to contribute to recorded species conservation

Only a small proportion of wood carvers had their own plantations which confirmed that the wood supply for this activity contributes to the fragmentation of natural forests and existing plantations throughout the country. All carvers confirmed their willingness to establish plantations if it were economically possible, and the majority of them would prefer plantations of *G. arborea* and *T. grandis*. They argued that *G. arborea* is a rapid growth species that can produce wood for sale and personal use in a short period of time and *T. grandis*, according to carvers, is a resistant and good quality wood. They also mentioned the trade of *T. grandis* wood for income generation as the species is highly demanded in carpentry in Benin and more widely in

the region. Similar to the present findings, carvers in Ghana indicated their willingness to use any type of wood provided the tools and equipment for processing them work well (Appiah-Kubi et al. 2014). The present findings also confirmed the results of McEwan et al. (2020) who stated that the factors influencing the form of plantation include the type and nature of the plantation owner, and the change in demand for different and new forest products. Forestry advisers and political leaders need to take such findings into account to promote plantations and ensure a sustainable wood carving industry throughout the country. In addition, carvers should be provided with tools for plantation management i.e. mechanical tools for site preparation in forest plantation for treatment of soils and vegetation to overcome constraints which include the use of scarification, mounding, and subsoiling/ripping, depending on machinery and attached equipment including multifunctional subsoiler, deep scarifier, subsoiler mounding, herb scalper, 2-disc motorized plow, deep subsoiler, prescribe fire, herbicides, eco-techniques (Lof et al. 2012, 2016, Collet et al. 2014).

Definitively, sustainable reforestation and timber species plantation would be promoted based on integrated policies such as (i) Developing appropriate silviculture; (ii) Sensitizing actors about forest conservation, the need for appropriate silviculture by giving priority to the quality of products and techniques at all stages; (iii) Strengthening forestry services capacities, consolidating technical achievements and monitoring forestry actions; (iv) Establishing, consolidating and developing sustainable self-promotion capacities of rural populations mainly women's groups, based on the integrated land development, beneficiaries entrepreneurial participation and the commercialization chain promotion at community and regional scales; (v) Creating and supporting institutional structures in monitoring learning; (vi) Promoting the advent of self-managed rural forestry based on the principle that reforestation really develops whether it can generate its own resources.

Conclusion

Many skilled artisans in Benin depend upon wood carving for their livelihoods. A diversity of species are used in carving in Southern Benin, the most used species being *D. mespiliiformis*, *C. excelsa*, *T. grandis* and *G. arborea*. *Gmelina arborea* and *C. excelsa* had the highest Use Value. Wood carving impacts on forest fragmentation and there is a need to promote reforestation and plantation, and to provide carvers with tools for plantation management such as, herbicides, prescribe fires, mechanical tools for Site preparation and eco-techniques. Carvers indicated their willingness to contribute to species

plantation and conservation. This investigation on woody species used in carving in Benin intends to stimulate the assessment of the ecological and dendrometric characteristics of the most used species in carving in order to better monitor the impacts of this activity, as well as screening financial aspects of wood carving.

Declarations

List of abbreviations: UCS: Union of Concerned Scientists; WWF: World Wildlife Fund

Ethics approval and consent to participate: All manuscripts must include a statement on ethics approval and consent (even where the need for approval was waived): Carvers gave their approval to participate in this research

Consent for publication: No individual person's data

Availability of data and materials: Data are available with authors and not deposited anywhere.

Competing interests: No competing interests.

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Authors' contributions: Ideas, formulation or evolution of overarching research goals and aims: Hubert O. Dossou-Yovo, Valentin Kindomihou. Management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later reuse: Hubert O. Dossou-Yovo, Valentin Kindomihou; Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data: Hubert O. Dossou-Yovo; Valentin Kindomihou; Investigation, Conducting the research and investigation process, specifically performing the experiments, or data/evidence collection. Hubert O. Dossou-Yovo, Valentin Kindomihou; Development or design of methodology; creation of models: Hubert O. Dossou-Yovo, Valentin Kindomihou; Management and coordination responsibility for the research activity planning and execution: Hubert O. Dossou-Yovo; Provision of study materials, reagents, materials, patients, laboratory samples, animals, seeds, plants, instrumentation, computing resources, or other analysis tools: Hubert O. Dossou-Yovo; Oversight and leadership responsibility for the research activity planning and execution: Hubert O. Dossou-Yovo; Verification, whether as a part of the activity or separate, of the overall replication/reproducibility of results/experiments and other research outputs: Hubert O. Dossou-Yovo, Valentin Kindomihou; Preparation, creation and/or presentation of the published work, specifically visualization of figures and table s/ data presentation: Hubert O. Dossou-Yovo, Valentin Kindomihou; Original Draft Preparation, (including substantive translation):

Hubert O. Dossou-Yovo; Valentin Kindomihou; Preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision - including post-publication stages: Brice Sinsin

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