

Research Article

Determinants of the Uses and Conservation of *Terminalia superba* in Forest Guinea

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Abstract

For centuries, human communities have relied on natural resources to satisfy their various needs (food, health, housing, etc.). Among these resources, *Terminalia superba*, a wood of high technological quality, is highly sought-after, which has led to strong pressure on its natural populations throughout its range, including Guinea. The present study assessed the factors determining the use and conservation of the species in Forest Guinea. Specifically, it aimed to i) assess the factors affecting the use values of *T. superba*, and ii) analyze the socio-economic factors controlling the conservation of *Terminalia superba* by rural communities. Data were collected on a random sample of 354 people in three prefectures (Lola, Macenta and N'Zérékoré) of Guinée Forestière. The relative frequency of users of the species (all forms of use combined) was calculated, and through a generalized linear model based on the Poisson distribution, the relationship between use values and respondents' socio-economic factors was analyzed. Logistic regression in a step-by-step selection approach was used to identify the factors controlling the retention of *Terminalia superba* plants in the fields. The relative frequency of use of *Terminalia superba* was 99.15%. The average number of uses reported per respondent was 1.92, with a coefficient of variation of 49.72%. Of all the factors involved, only gender had a significant effect on the number of uses reported, with men reporting more uses (mean = 1.97 and CV = 48.72%) than women (mean = 1.06 and CV = 22.91%). The final logistic regression model identified variables such as prefecture of residence, time spent in the village over 20 years, monthly income, main source of income, age category, marital status and level of education as factors controlling the retention of *Terminalia superba* plants by respondents in their fields. This study demonstrates the importance of the species and identifies the socio-economic factors of interest to be considered in programs for its valorization and conservation.

Keywords

Use Values, Terminalia Superba, Valorization, Guinea

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1. Introduction

Guinea's forest region, once rich in exceptionally lush and dense diversity, is nowadays in a state of advanced degradation. This situation is due to the combined effect of certain ecological and anthropogenic factors that are often at the origin of the massive mortality rates observed in the various forest stands [9]. Human activities have changed many aspects of natural fire regimes over time as humans have made extensive use of fire in their land management practices (agriculture, grazing, etc.) [12]. The increase in the frequency and intensity of these fires has led to the degradation of many forests, resulting in the disappearance of many species.

In the Guinean forest region, bushfires, mostly of anthropogenic origin, have led to the restructuring of many forest ecosystems, converting them into savannas. In this process of savanization, many forest species have been lost despite their importance to rural communities. Such is the case of *Terminalia superba*. Although *Terminalia superba* is a valuable resource, excessive logging and deforestation represent two major threats to the sustainability of this species [6]. Its wood is prized for its durability and strength. It is used for construction, furniture, flooring and other high-quality wood products. It is particularly appreciated in the manufacture of high-end furniture, doors and windows because of its beautiful texture and strength [6]. In Guinea, as in other West African countries, sustainable management of forest resources is a crucial issue.

In order to preserve this species, efforts are needed to encourage sustainable forest management, combat illegal logging and promote reforestation. The present study aims to: i) assess the factors affecting the use values of *Terminalia superba*; ii) analyze the socio-economic factors controlling the conservation of *Terminalia superba* by rural communities.

2. Material and Methods

2.1. Description of the Study Area

This study was conducted in the forest region in the extreme south of Guinea (Figure 1). This region comprises seven (7) prefectures: Beyla, Gueckédou, Lola, Kissidougou, Macenta, N'Zérékoré and Yomou. It borders Côte d'Ivoire, Liberia and Sierra Leone. It covers an area of 49,374 km², divided into sixty (60) rural communes (CR) and six urban communes. According to the third general population and housing census (RGPH III 2004), the region has a population of 1,578,030, with annual growth of 3.1% and a density of 42 inhabitants per km². The population is predominantly rural (73.6%) and made up mainly of ethnic groups such as: Kpèlè, Manon, Kissi, Konianké, Malinké and Toma.

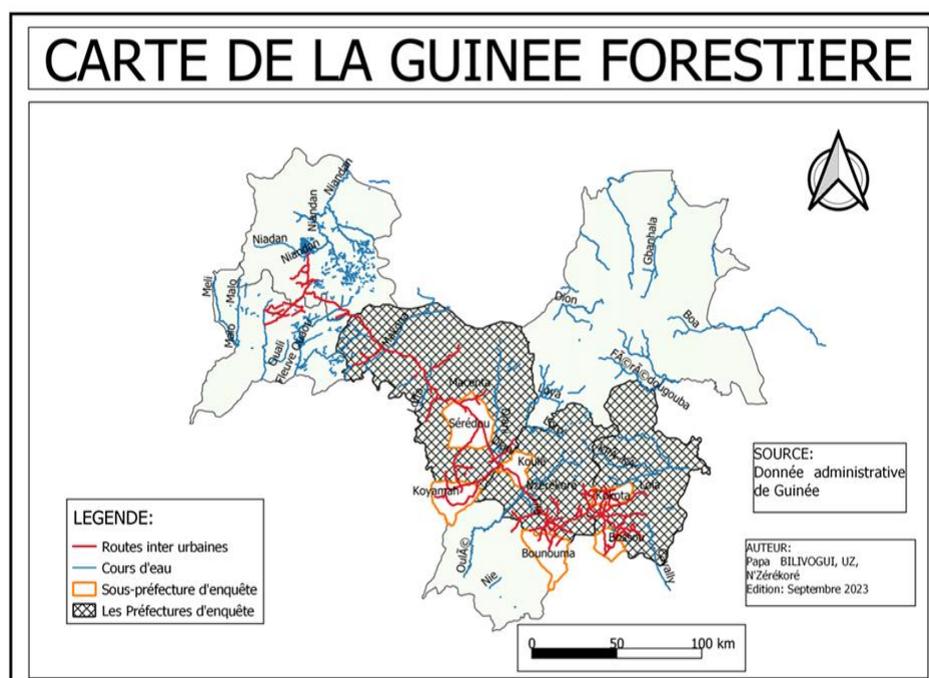


Figure 1. Study environment.

2.2. Sampling and Data Collection

In order to identify the factors influencing the natural regeneration of *Terminalia superba* in Forest Guinea, a socio-economic survey was carried out in three randomly selected prefectures in the region. These were Lola, Macenta and N'Zérékoré. The total number of people to be surveyed was determined using the normal distribution approximation with the following formula [3]:

$$n = \frac{U_{1-\alpha/2}^2 p(1-p)}{d^2}$$

With n being the total number of people to be surveyed.

$U_{1-\alpha/2}$ corresponds to the value of the random normal distribution for a probability of $1-\alpha/2$. $U_{1-\alpha/2} = 1.96$ for $\alpha = 5\%$; p = proportion of people having at least one foot of *Terminalia superba* in their fields. This proportion is determined during an exploratory phase ($p = 0.8$); d = margin of error ranging from 1 to 15%. Here $d = 5\%$.

For practical reasons, the sample size was set at 322, but this was adjusted to 354 respondents (Table 1). This number was distributed proportionally between the three prefectures (Lola, Macenta and N'Zérékoré).

The main actors surveyed were prefectural and sub-prefectural Eaux et Forêts authorities, people involved in the purchase and transport of wood, tradesmen using wood as a raw material, elders, farmers, hunters and others.

The data collected initially concerned the socio-economic characteristics of the respondents. Secondly, the various uses of the species were collected from the respondents. Secondly, data relating to the conservation of the species by the respondents were collected, with a focus on anthropogenic activities that have an effect on the natural regeneration of the species.

Table 1. Sample characteristics.

Factors	Terms	Number	Percentage
Prefecture	Lola	115	32,49
	Macenta	123	34,75
	N'Zérékoré	116	32,77
Sex	Male	337	95,20
	Female	17	4,80
Profession	Forestry Agent	7	1,98
	Hunter	29	8,19
	Timber Trader	57	16,10
	Farmer	103	29,10
	Local Elected Official	49	13,8'
	Logger	13	3,67

Factors	Terms	Number	Percentage
Age category	Carpenter	93	26,27
	Fisherman	3	0,85
	Young (under 40)	41	11,58
	Adult (40-60)	276	77,97
	Old (over 60)	37	10,45
Marital status	Single	5	1,41
	Married	325	91,81
	Divorced	4	1,129
Level of education	Widowed	20	5,65
	Illiterate	118	33,33
	Primary	172	48,59
	Professional	3	0,85
	Secondary	58	16,38
Lifespan in the village	University	3	0,85
	Less than 10 years	13	3,67
	10-15 years	22	6,21
Source of income	15-20 years	38	10,73
	Over 20 years	281	79,38
Source of income	Farm income	153	43,22
	Non-farm income	201	56,78

2.3. Data Analysis

2.3.1. Analysis of Factors Affecting *Terminalia superba* Use Values

Firstly, the relative frequency of use of the species (all forms of use combined) was calculated as the ratio of the number of respondents reporting use to the total number of respondents. Secondly, a generalized linear model based on the Poisson distribution was used to analyze the relationship between usage values (total number of reported uses per respondent) and respondents' socio-economic factors.

2.3.2. Analysis of Socio-economic Factors Controlling *Terminalia superba* Conservation by Rural Communities

The socio-economic factors determining *Terminalia superba* conservation by rural communities were identified using logistic regression. For this regression, the dependent variable is the retention of *Terminalia superba* feet [Yes/No], and the independent variables are the socio-economic variables (main source of income, monthly income, duration of more than 20 years in the village, duration of 15 to 20 years in the village, duration of 10 to 15

years in the village, duration of less than 10 years in the village, number of dependents, age range, level of education, marital status, gender, occupation and Prefecture of residence). The approach used is based on a step-by-step selection, with the result that only the variables of interest are included in the model.

For each of the model's significant qualitative variables, the relative frequencies of the modalities of each of these variables were determined. For significant quantitative variables, box-and-whisker plots were produced.

3. Result

3.1. *Terminalia superba* Usage Values and Determining Factors

The relative frequency of use of *Terminalia superba* was 99.15%. The average number of reported uses per respondent was 1.92, with a coefficient of variation of 49.72%. Of all the factors involved, only gender had a significant effect on the number of uses reported (Table 2). According to this factor, men reported more uses (mean = 1.97 and CV = 48.72%) than women (mean = 1.06 and CV = 22.91%).

Table 2. Result of the generalized linear model (Poisson family) between the number of reported uses and the socio-economic factors of the respondents.

Factors	ddl	Déviante	ddl résiduel	Déviante résiduelle	Prob.
Main source of income	1	0,7707	352	168,16	0,38000
Monthly income	1	0,4443	351	167,71	0,50459
Number of dependents	1	0,0685	350	167,64	0,79353
Age category	2	1,6908	348	165,95	0,42937
Educational level	4	2,4832	344	163,47	0,64764
Marital status	3	4,0285	341	159,44	0,25840
Gender	1	5,7310	340	153,71	0,01667*
Occupation	7	5,1473	333	148,56	0,64199
Prefecture	2	1,0575	331	147,51	0,58934

3.2. Socio-economic Factors Controlling *Terminalia superba* Retention by Rural Communities

The final model (Table 3) highlights variables such as prefecture of residence, time spent in the village over 20 years, monthly income, main source of income, age category, marital status and level of education as factors controlling the retention of *Terminalia superba* plants by respondents in their fields. This final model is globally significant (P-value < 0.001).

Table 3. Significance of factors in the final logic regression model.

Factors	ddl	Déviante	ddl résiduel	Déviante résiduelle	Prob.
Prefecture	2	46,072	351	211,79	< 0,001***
Living in the village for more than 20 years	1	16,738	350	195,05	< 0,001***
Monthly income	1	8,357	349	186,70	0,004 **
Age category	2	8,890	347	177,81	0,011*
Main source of income	1	5,615	346	172,19	0,018*
Marital status	3	7,723	343	164,47	0,052
Educational level	4	9,015	339	155,45	0,061
Gender	1	2,388	338	153,07	0,122

The Lola prefecture is characterized by a relatively high relative frequency (9.32%) for the *Terminalia superba* non-conservation modality compared with the other prefectures (Table 4). Also, respondents having spent more than 20 years in the village show a high relative frequency (73.45%) with regard to conservation of the species. In terms of age category, the high relative frequency of species conservation is observed among adults (68.64%). In terms of main source of income, people with non-agricultural incomes are more likely to conserve the species (48.59%).

Table 4. Relative frequency (%) of *Terminalia superba* conservation modalities according to significant variables in the final logistic regression model.

Variables	Conditions	Conservation of <i>Terminalia superba</i>	
		No	Yes
Prefecture	Lola	9,32	23,16
	Macenta	1,98	32,77
	N'Zérékoré	0,56	32,2
Over 20 years in the village	No	5,93	14,69
	Yes	5,93	73,45
Age category	Young	2,54	9,04
	Adult	9,32	68,64
	Old	0	10,45
Main source of income	Farm income	3,67	39,55
	Non-farm income	8,19	48,59

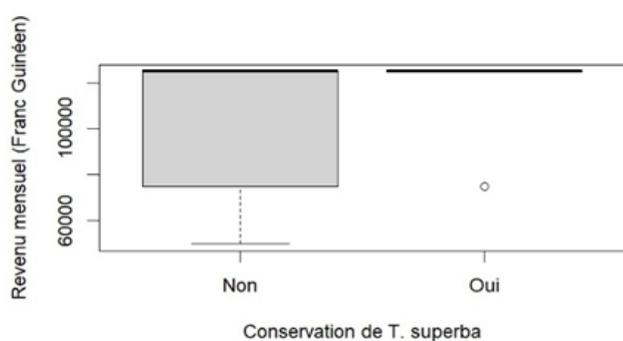


Figure 2. Monthly income as a function of *Terminalia superba* storage conditions.

In terms of monthly income, respondents who keep more of the species are those with a monthly income of over 100,000 Guinean Francs (Figure 2).

4. Discussion

4.1. T. Superba Use Values and Determining Factors

Natural ecosystems and wild species of animals, plants, and fungi are generally used to meet the basic needs of local communities [16]. Natural resources are therefore of paramount importance for improving food security and the living conditions of local communities [17].

This study revealed that 99.15% of *Terminalia superba* is used throughout the Guinean forest region. This indicates the social, economic and cultural importance of the species to the various local communities, who use it in many areas of daily life, including carpentry, construction and handicrafts. The strong dependence of these communities on the species lies in its technological properties, ranging from its lightness as a timber to its resistance to pests. According [7, 10], these technological features give the species an inescapable durability that makes it widely used in people's daily lives.

Several authors [4, 8], through their studies carried out in Benin and Cameroon, have shown that thanks to the species' great variability, it offers flexibility in these uses. Furthermore, an average of 1.92 ± 49.72 uses per person revealed by our study reflects a great dissimilarity in the manner of use or accessibility to the species but also to attributes specific to each individual. According to the work of [11], the way in which individuals perceive opinions fluctuates significantly according to the life stage of the species, access to the market and different techniques.

The results of our study also revealed a significant gender disparity in the determinants of factors linked to the use of *Terminalia superba*. They reveal that men use the species more frequently than women. The essence of this difference lies in the fact that there is gender inequality with regard to access to production resources and services in rural areas, where wood harvesting and/or processing activities are mostly the preserve of men, giving them a certain foresight in the application of techniques related to the species [2, 4]. This gender divergence has been extensively documented by [14], who have worked extensively in the field of forest resource management. Notwithstanding the low involvement of women in the commercialization of this wood, thus reducing their access to the various possible applications of the species, the fact remains that these women are more involved in the more medicinal and domestic uses of the species. This observation is supported by the work of [15], in which it is shown that in northern Benin, men have greater control over access to wood, while women are confined to the use of non-timber forest products.

4.2. Socio-economic Factors Controlling *Terminalia Superba* Conservation by Rural Communities

The results of the logistic regression analysis used identified the tiers that determine *Terminalia superba* conservation by rural communities. In our study, the factors of belonging to a given prefecture, time (over 20 years) of having lived in the village, monthly salary, main source of income, as well as age bracket are the most decisive in decision-making. For authors such as [5] from Benin, [13] from Burkina Faso, the factors that determine the use of the species are age in the village and the region to which it belongs, which has an impact on the way the resource is conserved. This indicates that the longer people live in their village, the better they participate in the preservation of the species, since individuals develop a certain affinity with the species, leading to rational use behaviors.

Similarly, a positive relationship between length of residence and intensity of use was established in the course of the study, reflecting a plethora of local know-how emphasized by [1] in rural areas of Côte d'Ivoire and Togo. Socio-economic factors such as level of education, marital status and gender do not have a major impact on reported usage values. Indeed, within organized economic groups based on gender divergence, the use of *Terminalia superba* results from a certain level of compromise, which may explain the insignificance of these variables, due to the qualitative approach used.

Finally, within the communities that use the species, the adults who use the species occupy a prime position, which points to age as a determining factor for *Terminalia superba* in our study. In forest species conservation programs, combining both local ecological and socio-economic dimensions would be more effective in that it establishes an integrative approach that takes into account local knowledge derived from the experience of these adults and their particular relationship with the species.

5. Conclusion and Recommendations

The aim of the study was to identify the factors determining the uses and conservation of *Terminalia superba* in the economic fabric of Forest Guinea. The study showed that the species is mainly used by men, and much more so for construction work. Significantly determining factors found included time of residence, income, source of income and age category. However, the high use of the species by the region's communities is not combined with a rational management system to ensure its sustainability. Thus, for a better strategy of exploitation and conservation of the resource, the natural regeneration route can be favored by allowing the germinated *Terminalia superba* seeds to thrive and develop in natural conditions without human intervention. For this reason, long fallow periods must be observed, bush fires and slash-and-burn cultivation limited, and rational exploitation of timber must be carried out. Furthermore, the integrated management method

through awareness-raising and participation of local communities based on local knowledge is essential for the development and sustainability of biodiversity.

Author Contributions

Papa Bilivogui: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Validation, Writing - original draft, Writing - review & editing

Hermann Léonce Zinsou: Conceptualization, Resources, Supervision, Validation, Writing - original draft

Achille Hounkpevi: Data curation, Formal Analysis, Methodology, Software, Validation

Alexandre Konate: Conceptualization, Methodology, Software, Supervision

Diawadou Diallo: Conceptualization, Software, Supervision, Validation

Conflicts of Interest

The authors declare no conflicts of interest.

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