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Spatial Distribution and Growth Potential of Economically Important Rattan Species in Cameroon Seen Through the Lens of Indigenous Populations

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Keywords: Distribution, rattan, maturity, growth potential, indigenous population, Agroecological Zone, Cameroon

Posted Date: October 11th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-936659/v1

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Abstract

Background: Rattan is an important Non-Timber Forest Product (NTFP) with huge potentials to boost socio-economic development in indigenous communities of Cameroon in particular and the entire country in general. Exploitation is from the wild, with no implication of stakeholders in renewing the resource, thus leading to resources scarcity. Insufficient knowledge on rattan's growth potentials in Cameroon jeopardize resource regeneration and renewal. It was in this context that this study was initiated to (i) determine economically important rattan species distribution; (ii) identify their habitats and conservation status; (iii) examine harvester's perceptions/observations on annual growth rate and age to maturity.

Results: It was found that *Eremospatha macrocarpa* exist in all AEZs, *Calamus deerratus* was found in AEZ 2 & 5, *Laccosperma Secundiflorum*, *L. Robustum*, was found in AEZ 3, 4 and 5 and *Eremospatha wendlandiana* was found only in AEZ4. They grow in diverse habitat/environments with some habitats/environments specifically suitable for some rattan species. The current conservation status of commercial rattan species identified shows Least Concern (LC); but resource scarcity in high. Most harvesters observed that rattan takes either 2 – 3 years (51%) or 4 – 5 years (35%) to attain maturity. The harvesters' observation on annual growth rate of economic rattan species varied in relation to the species and AEZs, nevertheless, globally 25% and 23% of the respondents observed a growth rate of 2-3 m and 3-4 m respectively. Kruskal-Wallis test shows a significant variation in harvesters' perception in the different AEZs for all growth and maturity parameters of different rattan species ($p<0.05$) except for the number of years it takes for rattan to attain maturity ($p>0.05$)".

Conclusions: All five economically important rattan species are highly distributed in the Southern zone of Cameroon. The availability of *E. macrocarpa* in all zones indicates its great adaption. Renewing (plantations) rattan resource implies appropriate planting in the Southern and Coastal regions of Cameroon, since the all the species inhabit and grow rapidly. This is important to policymakers and development planners for policy reformulation towards the sustainable development of rattan in Cameroon.

1. Introduction

Rattans are species of spiny climbing palms that belong to the subfamily Calamoideae of Arecaceae family. There are 11 genera belonging to 631 rattan species reported in Asia-Pacific and Africa, among which *Eremospatha, Laccosperma* and *Oncocalamus* are endemic genera restricted to Africa, while the remaining genera are distributed throughout the Asia-Pacific region (excepted African genera of *Calamus*) (Vorontsova et al., 2016). Indonesia, which accounts for over 300 rattan species (Bastian, 2013), is the leading country in harvesting and exportation of rattan, making up to 80 – 90 % of the total global rattan production (FAO, 2011). Sunderland (2001; 2012) reports the presence of 22 rattan species in West and Central African Regions. Of these known species, 19 occur in Cameroon (Gonmadje et al., 2018a).

Rattan can grow in diverse conditions which vary in function of rattan species (Sunderland, 2001; Titi & Prameswari, 2018; Gonmadje et al., 2018a). In Africa Rattans are clustering i.e. they produce numerous stems from one individual (Sunderland, 2001; Mialoundama, 2020). These rattan stems or canes, are covered at first by the tightly sheathing and often densely spiny leaf bases. According to Sunderland (2001), the diameter of rattan stems are relatively constant within species and hence it is possible to distinguish between “small-diameter” (<20 mm) and “large-diameter” (>20 mm) species. For Dransfield et al. (2002), rattans can be found in diameters between 3 mm to 20 cm. The stem length of some rattans have been recorded as reaching up to 175m in length (Burkill, 1935). In Africa, the stem length average of rattan species is between 30-50m (Sunderland, 2001). Nevertheless, for *Eremospatha macrocarpa,* the stem length at maturity can attain 150m (Sunderland, 2001). The canes of rattan grow at an average rate of 0.70 m per year (Sunderland, 2001). However, the growth rate vary significantly with respect to rattan species, environmental conditions and also the management strategies (Razali et al. 1992; Sunderland et al. 2012). Rattans in Africa are essentially distributed wild. Due to its strength, flexibility and pliability it is largely used across many sectors but not only limited to the making of furniture, household items, baskets and even bridges (Olawale & Wasiu 2013; Myers, 2014; Gonmadje et al. 2018b).

The position of rattan on the world market is expanding due to increasing demand for environmentally friendly products in Europe and the United States. The world’s rattan sector is estimated to generate a global revenue of USD 10 billion annually (Myers, 2014; Gonmadje et al., 2018a). In Africa, throughout the lowland tropical forest zone, the climbing palms, or rattans form an integral part of subsistence for many rural populations and provide the basis of a thriving cottage industry (Sunderland, 2001, Mialoundama, 2020). In this regard, African rattans have long been recognised by donor agencies and national governments as having a potential role to play within the domestic and regional Non-Timber Forest Product (NTFP) sectors, as well as within the significant global rattan market (Sunderland, 2001; Mialoundama, 2020).

In Cameroon, Decision No. 0209/D/MINFOF/CAB of 26 April 2019 classifies special forest products and Non-Timber Forest Products (NTFPs) under which rattan is classified in category B: being moderately threatened forest resource. *Laccosperma secundiflorum, L. robustum, Eremospatha macrocarpa, E. wendlandianna* and *Calamus deerratus* are regarded as the main commercial species of rattan in Cameroon (Gonmadje et al., 2018a). According to Gonmadje et al. (2018b), the rattan harvesting cycle can take 3-4 years and collectors harvest 10-15 stems per month for which the cost of a bundle varies between 3.54 $ in rural areas to 21.21$ in urban areas. Studies on rattan diversity, distribution, biophysical and value chains have been widely undertaken in Cameroon, but not across all agro-ecological zones (AEZs). Indigenous knowledge regarding growth rate and number of years it takes for commercial rattan species to attain maturity is limited in Africa and more especially in Cameroon. Whereas, this information is capital to making recommendations to policymakers and development planners geared towards ensuring the sustainable management of these commercial rattan species. It is in this context that this study was initiated to understand the perception/observations of rattan harvesters on growth potential of economically important rattan species in Cameroon in order to better

understand the areas where rattan thrives. More specifically, the study seeks to (i) determine the spatial distribution of economically important rattan species identified in Cameroon; (ii) determine the Habitats and rattan conservation status in Cameroon; (iii) examine the perceptions/observations of rattan harvesters concerning annual growth rate and number of years taken by Economically Important Rattan Species identified to attain maturity.

2. Materials And Methods

2.1 Study Area

This study was carried out in four out of the five agro-ecological zones (AEZs) of Cameroon i.e. zones identified in literature as home to commercial rattan species. Cameroon is found in the Central African sub region, located between Latitude 2° N to 13° N and Longitude 8° 25° E and 16° 20° E. It opens to the Atlantic Ocean on the West with a total coastline of 402 km. It is bordered to the west by Nigeria, to the North-east by Chad, to the South by Gabon, Congo and Equatorial Guinea and to the East by the Central African Republic. It has a total surface area of 475 650 km (MINFOF, 2018). This country known as “Africa in miniature”, is highly ecologically diverse. Biophysical parameters of the different AEZs of Cameroon are summarized in table 1. Phytogeographically, the AEZs are made up of the Sudano-Sahelian zone, Sudano-Guinean high savannah, Western highlands, Monomodal and Bimodal rainfall forest (AEZ1, AEZ2, AEZ3, AEZ4 and AEZ5).

Table 1. Biophysical characteristics of AEZs sampled in Cameroon

AEZs	Climate	Rain fall (mm)	Altitude (m.a.s.l.)	Mean annual temperature (range)	Main soils
AEZ1	Tropical Sudano-sahelian	500-900	250-500	28°C (7.7)	Ferruginous
AEZ2	Tropical Sudano-Guinean	1500-1800	500-1500	23°C (6.4)	Hydromorphic and ferralitic
AEZ3	Tropical Sudano-Guinean	1800-2400	1500-2500	21°C (2.2)	Granitic, lateritic and alluvial
AEZ4	Sub-equatorial	2000-11000	0-500	26°C (2.8)	Vertisols and ferralitic
AEZ5	Guinean Equatorial	1500-2000	400-1000	25°C (2.4)	Hydromorphic and ferralitic

Meters above sea level (m.a.s.l); Source: Toukam et al (2009)

2.1.3 Sampling

This study targeted selected commercial rattan species and their production zones within the different AEZs for sampling, with the exclusion of AEZ 1 (North and Far North Regions) due to absence of rattans as expressed in literature and the North-West and South-West Regions due to the current socio-political crisis rocking the area. Sampling sites included the following: Mbigoro I, Batoua Pangar, Dobiri, Mbella, Bindiba and Sourma in Dir Sub-Division, Mbere division, Adamawa Region (AEZ 2); Magba, Malentouen and Massangam Sub-Divisions in the Noun Division, West Region (AEZ 3); Campo, Kribi 1 and Lokoundje Sub-Divisions in the Ocean Division, South Region; Edea in Sanaga Maritime Division and Douala 3 in the Wouri Division, Littoral Region (AEZ 4). In AEZ 5, sampling took place in Mbalmayo Sub-Division (in Zamakoe, Yup, Ndik and Abang villages) and Ngambe-Tikar sub-division, Centre Region; Abong Mbang division, Dimako Sub-Division, Bertoua 1 Sub-Division, Batouri Sub-Division, Belabo Sub-Division, in the East Region of Cameroon. These communities were purposively sampled based on prior information from literature (e.g. Sunderland et al. 2012; Gonmadje et al., 2018a) of the existence of rattan species in the community as well as the development of rattan value chain in these communities.

2.2. Data collection

In each AEZ, data collection was carried out in the localities identified as study sites from literature as zones where people were involved in rattan harvesting and selling. The methodological approach involved the administration of semi-structured questionnaires to persons involved in the rattan sector. The questionnaires were framed to address issues related to rattan species commercialised, collection sites, collection season, annual growth rates, and number of years taken for rattan to get to maturity. A total of 117 questionnaires were administered to rattan harvesters in 25 villages in 4 AEZs. This number of questionnaires were administered because of the few persons who were found in the community at the time of the survey, who were directly involved in the rattan value chain development (harvesters and producers). In most cases the harvesters were also the producers and direct sellers of the products.

For the distribution of the economically important rattan species, each village had a focus group discussion (FGD) organised with representatives of rattan dealers, chiefs, chief of forestry post, rattan craftsmen and women, civil society organisation, farmers from the village. The FGD assembled between 10 – 20 people. Informants in some of the villages were used to translate from local Languages to French for proper understanding of the questions. This was in few communities where French language is not understood. This was to gather general information on rattan activities in the village such as identifying the villages, their main activities, rattan availability, those involved mainly in the harvesting and selling, places of harvests and distances from the village. Informants were selected at the group meeting to accompany investigators to collection sites. Field inventory was carried out in the different AEZs. Field assistants (informants) rattan harvesters accompanied investigators to harvesting sites for preliminary identification of commercial rattan species. Besides collecting information on the habitats/ecological niche, rattan specimen's vouchers and clean photographs of unidentified species were collected with the help of a pruning shear and a camera respectively. GPS coordinates of specific rattan species collection sites were recorded on data sheets from the field. In the analysis, coordinates of commercialised rattan species from the database of the "taxonomic revision of the rattans of Africa"

(Sunderland, 2012), were used to complete those collected during this study to produce a map showing the distribution of commercial rattan species in Cameroon. The taxonomic revision of the rattans of Africa (Arecaceae: Calamoideae) (Sunderland, 2012) was used to complete the identification.

2.3. Data Analysis

Data was coded in an excel sheet, processed and transferred into SPSS software where descriptive and inferential statistics were performed. Descriptive statistics computed were frequency tables, charts and percentage indices while inferential statistics computed was the Kruskal-Wallis statistical test at 95% confident interval which was used to compare growth and maturity parameters across the different agro-ecological zones.

3. Results

3.1 Spatial distribution of economically important rattan species identified in Cameroon

The inventory results of the commercialised rattan species in the different localities visited during this study showed that of the 5 commercial rattans species identified, *Eremospatha macrocarpa* was rattan species found in all the four different sampled AEZs. This was followed by *Laccosperma secundiflorum* and *Laccosperma robustum* found in all sampled AEZs except AEZ2. *Calamus deerratus* was found in AEZs 2 and 5 and *Eremospatha wendlandiana* was encountered only in AEZ 4. Figure 1 shows the geographical distribution of these economically important rattan species according to the different AEZs of this study.

3.2. Habitats and rattan conservation status in Cameroon

All rattan species in Cameroon have low concern (LC) status according to the IUCN (2020) red list (Table 5) and also at national scale according to Onana (2011). However, most of these commercial rattan species are locally threatened due to over-exploitation (because of significant increases in market demand), as well as habitat loss due to agricultural expansion, bush fire, logging resulting in significant decline in wild rattan stocks. The Guinean-Congolese forest type of Cameroon is a host to different rattan habitats (Table 2), reason why all these species are present and undergoing exploitation.

Table 2. Habitat and conservation status of rattan in Cameroon

Rattan species	Habitats/ ecological niche	Level of market demand	IUCN status	Local status
C. deerratus (small diameter)	Strong preference for swamp and moist forest	Very low	LC*	Locally threatened by habitat loss
E. macrocarpa (small diameter)	Extremely light demanding, occurring naturally in gap vegetation and forest margins.	Very high	LC*	No major threat
E. wendlandiana (small diameter)	Common component of gap vegetation and forest margins, although it is commonly present in the juvenile form in closed-canopy forest.	Average	LC*	No major threat
L. secundiflorum (Large diameter)	High forest, and is commonly found under a forest canopy	Very high	LC*	Locally threatened due to habitat degradation and habitat loss (agricultural expansion, high economic value, etc.)
L. robustum (Large diameter)	Commonly encountered in degraded forest areas and regrowth vegetation and responds well to selective-logging activities. It is encountered on both moist tropical forest and seasonally-inundated forest.	Very high	LC*	Locally threatened due to habitat degradation and habitat loss (agricultural expansion, high economic value, etc.)

*Least Concern (LC)

3.3. Maturity of Economically Important Rattan Species in Cameroon

Observations of rattan harvesters show that, the number of years taken to maturity for economically important rattan species vary with respect to the rattan species (Table 3). In fact 51% of harvesters are of the opinion that without rattan species distinction it takes 2-3 years to reach maturity; and only 2% opine that it takes more than 7 years to reach maturity. However, this point of view varied in function of rattan species considered (Table 3).

In the same case, local harvester's perception concerning the number of years required to reach maturity varied in function of AEZ. For *E. macrocarpa*, 50% harvesters in AEZ 2 observed that it takes 2-3 years to reach maturity; 17 % each mentioned that it takes < 2 years, about 4-5 years and 6-7 years respectively. In AEZ 3, 40 % mentioned that *E. macrocarpa* takes 2-3 years to reach maturity; 40 %, 10% and 5% of respondents mentioned that it takes 4-5 years, < 2 years and 6-7 years and above respectively to reach maturity. In AEZ 4, 95 % observed that *E. macrocarpa* takes 2-3 years and in AEZ 5, 67 % respondents observed that it takes 2 -3 years, and 23 % observed that it takes 4-5 years to reach maturity. For *C. deerratus*, 50% harvesters in AEZ 2 mentioned that it takes 2-3 years for this rattan species to reach maturity; 16.7 % respondents observed that it takes < 2 years, 4-5 years and 6-7 years respectively. In AEZ 5, 67 % were for 2 -3 years, 23% observed that it takes 4-5 years to reach maturity. For *E. wendlandiana,* in AEZ 4, it takes 2-3 years for this species to reach maturity; 16.7 % respondents observed that it takes < 2 years, 4-5 years and 6-7 years to reach maturity. For *L. secundiflorum* and *L. robustum* species got similar response on age of maturity in the different AEZs. 50% of harvesters in AEZ 3 observed that it takes 2-3 years, 35% observed that it takes 4-5 years, 10% and 5% observed that it takes 6-7 tears and > 7 years, respectively. The same tendency was found also in AEZ5 except for 1% of the respondents who observed that it takes < 2 year. In AEZ 4, all harvesters (100%) said that, it takes 2-3 years. In AEZ 5 it takes the same 2-3 years.

Table 3. Observations of respondents pertaining to the number of years taken by rattan species to attain maturity

Commercial rattan species	< 2 years	2-3 years	4-5 years	6-7 years	⩾7 years
C. deerratus	5%	59%	30%	5%	1%
E. macrocarpa	3%	40%	45%	9%	3%
E. wendlandiana	6%	48%	32%	12%	2%
L. secundiflorum	1%	65%	28%	4%	2%
L. robustum	2%	45%	40%	9%	4%
For all rattan species	4%	51%	35%	8%	2%

3.4. Annual Growth Rates of Rattan in Cameroon

Observations of rattan harvesters show that, the annual growth rate for economically important rattan species identified range from less than 1 m to more than 6 m per year. This perception is not the same for all these species. For example, for 44 % of the respondents, the annual growth rate of *L. robustum* is 1-2 m whereas for *E. wendelandiana,* only 11% of harvesters thinks that the annual rate is 1-2 m. For the most respondents (32%), without rattan species distinction, rattan annual growth rate is 5-6 m. For 23 and 25%, annual rattan growth rate is 1-3m and 3-4 m respectively (Table 4).

It is important to note that in function of AEZs and for each rattan species, the point of view of harvesters varied. Then, the harvesters observed that *E. macrocarpa* in AEZ 2 grows about 1-2 m (66.7 %) and 3-4 m (33.3 %) per year. In AEZ 3, the respondents observed that growth is about 1-2 m (50 %); < 1 m (30 %); 3-4 m (15 %) and 5-6 m (5 %). The growth of rattan poles was about 5-6 m (26.3 %); < 1m (26.3 %); 3-4 m (30.6 %) and 1-2 m (15.8 %) in AEZ4. In AEZ5; it was > 6 m (56.9 %); 1-2 m (22.2 %), < 1 m (12.5 %) and 3-4 m (5.6 %) and 5-6 m (2.6 %). For *E. wendlandiana* an annual growth rate estimated by harvesters is 5-6 m (for 26.3 %); < 1m (26.3 %); 3-4 m (30.6 %) and 1-2 m (15.8 %). For *Large Diameter Rattan* like *L. secundiflorum* the harvesters observed that an annual growth rate of 1-2m (75 %) and 3-4m (25 %) in AEZ3; 1-2 m (57.9 %); < 1 m (10.5 %); 3-4 m (15.8 %) and 5-6 m (15.8 %) in AEZ4 and in AEZ5; it was > 6 m (56.9 %); 1-2 m (29 %), and 3-4 m (15.3 %). For *L. robustum* species the results found concerning annual growth were 1-2 m (58 %); < 1 m (10.5 %); 3-4 m (15.8 %) and 5-6 m (15.8 %) in AEZ4 and in AEZ5; it was > 6 (57 %); 1-2 m (29 %), and 3-4 m (15 %).

Table 4. Observations of the local population concerning the annual growth rate of rattan species

Commercial rattan species	<1 m	1-2 m	3-4 m	5-6 m	6 m
C. deerratus	3%	21%	29%	32%	15%
E. macrocarpa	5%	17%	40%	31%	7%
E. wendlandiana	1%	13%	23%	45%	8%
L. secundiflorum	1%	44%	17%	3%	35%
L. robustum	2%	19%	15%	48%	16%
For all rattan species	2%	23%	25%	32%	16%

Comparing the observations of harvesters on growth potentials of rattan species in the different AEZs, the statistical test shows that, a significant variation exists in harvesters' observation across the different agro-ecological zones for all the variables ($p<0.05$) except for the number of years it takes for rattan to get to maturity ($p>0.05$) (Table 5).

Table 5. Observation of harvesters on growth pattern of rattan species in the different AEZs

Test Statistics	Number of years it takes for rattan to get to maturity	Which species of rattan grows faster	How fast does small diameter rattan grow per year	How fast does large diameter rattan grow per year	How long does it take for small diameter rattan to get to maturity	How long does it take for large diameter rattan to get to maturity
Kruskal Wallis	5.533	14.303	24.414	33.440	18.046	17.367
Asymp. Sig.	.137	.003	.000	.000	.000	.001

a.Kruskal Wallis Test, b.Grouping Variable: Agro-ecological zones; Dl:3.

3.5. Harvestable lengths for commercially important rattan species in the different AEZs

Harvesters collected rattan in different AEZs with respect to certain lengths as seen in the Table 6. The different lengths depend to an extent on the accessibility to rattan collection zones, the distance from the forest to the roadside. Small diameter rattans were harvested and tied in bundles of 20 canes, with lengths of 5 m. The large canes were harvested and tied in bundles of 10-15 canes with lengths of 3-5 m in AEZ 3, and 15- 20 canes with lengths of 5 m in AEZ 4.

Table 6: harvestable lengths of cane with respect to the entire rattan lengths

AEZs	Rattan species	Life growth length (m)	Harvestable length (m)	Number of canes per bundle	Remarks
1	*E. macrocarpa*	50–75 m and rarely to 150 m	15-20	-	do not tie in bundles
	C. deerratus	≤ 20 m	5-10	-	do not tie in bundles
2	*E. macrocarpa*	50–75 m and rarely to 150 m	20-25	20	sold per cane
	L. secundiflorum	30–45 m	3-5	10 - 15	
	L. robustum	25-50 m	3-5	10 – 15	
3	*E. macrocarpa*	50–75 m and rarely to 150 m	70-80	20	sold per cane
	L. secundiflorum	30–45 m	3-5	15 - 20	
	L. robustum	25-50 m	3-5	15 - 20	
	E. wendlandiana	≤ 60 m	35-40	20	
4	*E. macrocarpa*	50–75 m and rarely to 150 m	65-75	20	Sold per cane
	L. secundiflorum	30–45 m	20-25	15 – 20	
	L. robustum	25-50 m	20-25	15 – 20	
	C.deerratus	≤ 20 m	5-10	20	

4. Discussion

4.1. Spatial distribution and habitat of commercial rattan identified

The distribution of economically important rattans species reached their northernmost limit in the Southern Adamawa Region of Cameroon. At the extreme northern limit, it is possible that they may occasionally be subjected to temperature range of 20-36 ° Celsius. In altitudinal range rattan thrives at an altitudinal range between 800 to 2000 m. Moving Southwards, rattan distribution in species diversity and density increase toward the sea coast (Littorals); this is why more commercial rattan species were found in AEZ4. Precipitation is also one parameter that conditioned rattan species; in fact, annual rainfall that favour rattan varies from 539 – 2,685 mm; this can explain the absence of rattan in sahelian agroecological zone of Cameroon. Concerning vegetation type, we can note also that some rattan species prefer some ecology compared to the other. In Cameroon, Gonmadje et al. (2018a) found for example that *C. deerratus* is found in swamp and wet forest and *L. secundiflorum* is commonly found under a forest canopy. Globally, climate condition, soil type and vegetation appear like some of the factors that influence the distribution of rattan species (Balagopalan & Sankar, 1992; Sunderland, 2001, Gonmadje et al., 2018a, Mialoundama, 2020).

Logging and agricultural expansion, slash-and-burn agriculture are the main anthropogenic activities which have direct impacts on the forest cover (FAO, 2010) and other plant and animals species; which is the case for commercial rattan species in this study. However, even with the rattan species found, they are of low concern according to the IUCN red list, but we found that commercial rattan species will be threatened in the nearest future as is the case of some rattan species in some localities where they are already locally threatened. In addition, we observed over-exploitation of some species (because of significant increases in market demand), resulting in significant decline in wild rattan stocks. One key informant mentioned that “due to the rarity of rattan raw material today we walk more than 10 km inside the forest to collect rattan cane”.

4.2. Maturity of rattan

We obtained diverse viewpoints of local people concerning the number of years commercial rattan take to be mature. These points of view vary not only in regard to the local people of each AEZs but also with respect to the small or large diameter of commercial rattan species. However, for the majority of local rattan harvesters, rattan gets mature in 2-3 years. These findings are different from those of Muralidharan et al. (2020) who show that for *C. rotang*, *C. thwaitesii* and *C. hookerianus* (small diameter), it will reach maturity in about 6-7 years and 10–12 years for large diameter rattan species. Also Razali et al. (1992) reports on the age of maturity of certain species of the genus *Calamus* thus: *Calamus trachycoleus* takes 7-10 years to reach maturity in Kalimantan; 10 years in East Kalimantan and 7 years in an undefined location. *Calamus tetradactylus* takes 6 years to reach maturity in China. *Calamus caesuis* takes 6-8 years to reach maturity in Indonesia, 10 years in East Kalimantan and 3 years in Kalimantan. Few (1992)’s conservative model assumes that each stem of *C. caesuis* is harvestable at the age of 8 years and that of *Calamus trachycoleus* is harvestable at the age of 7 years. Supardi and Aminuddin (1992) reports suggest timing for harvesting of *C. manan* is 12-15 years. In this study, 2-3 years is reported in Cameroon as harvesters’ observation, which is far different from previous studies. Harvesters’ observation on age of rattan maturity at this level may have been influenced by scarcity which cause

harvesters to resort to harvesting rattan that has not attain its full maturity in Cameroon, and the situation makes them to believe that, this age range 2-3 years is the mature age for the rattan canes. Rattan age of rotation might also have confused harvesters' notion of maturity for rattan. Another difference may be from African rattan which are different in species from Asian Pacific regions. Therefore, we believe that the number of year required for rattan to reach maturity vary with respect to rattan species.

4.3. Growth rate of commercial rattan species of Cameroon

Different authors report findings on annual growth rates on rattan species. Razali et al. (1992) records the growth rates of *C. caesuis* and *C. trachycoleus* in managed holding to be 3 m/year and in unmanaged holding to be 2 m/year in Indonesia. This author summarises other studies in different study areas thus: the growth rates of *C. caesuis* in East Kalimantan is 4 m/year and that of *C. trachycoleus* in Sabah is 3 m/year, in East Kalimantan is 5 m/year, in Central Kalimantan is 4 m/year. Few's (1992) model of conservation assumes that *C. caesuis* cane growth rate is 2.5 m/year giving a total stem length of 20 m after 8 years. The growth rate of *C. trachycoleus* is assumed to be 3.5 m/year giving a total stem length of 24.5 m after 7 years. Sunderland et al. (2008) report a growth rates of 3.2 m for the multi-stemmed small-diameter cane *E. macrocarpa* when compared to similar species, *Calamus caesuis* in South East Asia with annual growth rates between 2.9-5.6 m. Based on harvesters' observations of the growth rate of *E. macrocarpa*, estimate from the majority of respondents show 1-2 m/year. This finding is quite different from those of several authors. Only 33.3% of harvesters have related a growth rate of 3-4m/year which are close to those reported previously by several authors.

From empirical findings, Sunderland (2012) shows the morphological length of *L. secundiflorum* to be averagely 25-50 m at maturity. Also, Muralidharan et al. (2020) find the age to which large diameter rattan attain maturity to be 10-12 years. Assuming the results of these two authors are correct, for growth length and age at maturity for *L. Secundiflorum*, and then extrapolate the growth rate for *L. Secundiflorum* to be (25-50/10-12) 2.5-5 m/year- 2.1-4.2 m/year. This estimated growth rate quadrupled the harvesters' observation. Also, for *E. macrocarpa,* Sunderland (2012) found that the morphological length to be averagely 50–75 m at maturity; and Muralidharan et al. (2020) show the age to which small diameter rattan attain maturity to be 6-7 years. Thus, from the two studies, the age and growth length at maturity for *E. macrocarpa,* and the growth rate for *E. macrocarpa* can be extrapolated as (50-75m/6-7) 8.3-12.5m/year / 7.1-10.7m/year. This information confirms also the annual growth rate which vary with respect to rattan species. Some rattan species are qualified to very rapid in growth compared to others like observed by harvesters; and which is confirmed by several authors (eg. Sunderland 2008, 2012; Muralidharan et al. 2020). This can be related also to the influence of environmental and phytogeographical conditions. In fact, the results show that rattan growth rate is faster in the Coastal region characterised by the Classical Guinean Equatorial, Guinean Equatorial climates than in the Guinean Equatorial and Tropical Humid climates zones in Cameroon. Moreover, Supardi and Aminuddin (1992) observe *C. manan*'s, growth rate of 1-3m/year in adequate light conditions and in rubber plantations. Supardi and Aminuddin (1992)'s results confirm that the growth rate of rattan is not constant, but dynamic. It vary with respect to the development stage because it starts up slowly in the

early 1-3 years, doubles, triples or even quadruples in its later developmental stage. An average growth length of 9.98 m in an 8.2-year rattan plantation is recorded in Dengkil, Solangor (FAO, 2005).

This study's literature has limited actualized data due to the limited studies in the region Africa.

Conclusion

In Cameroon, rattan's northern limit is the South of Adamawa and it is found mainly in the Southern part of the national territory. *E. macrocarpa* is distributed in all the different studied AEZs. Current conservation status of rattan showed that they have least concern (LC) but facing exploitation pressures in Cameroon. Rattan harvesters observed that *Eremospatha, Laccosperma* and *calamus* take 2-3 years to attain maturity and *Eremospatha, Laccosperma* and *calamus* possessed similar annual growth rates in the different AEZs. Small diameter rattan (*Eremospatha*) constituted the longest growing lengths per year likely > 6m. Harvesters perceived rattan to grow and attain maturity than really what it is.

Having this information has the following implication on rattan sustainability in Cameroon: economically important rattan species with respect to their ecological zones can easily be promoted for planting, for better performance yield. This also has implications in policy reformulations as policymakers and development planners can orientate the sustainable development of this rattan resource with respect to their distribution, high quality yielding and growth rates per ecological zone.

Declarations

- **Ethics approval and consent to participate**

"Not applicable"

- **Consent for publication**

"Not applicable"

- **Availability of data and material**

The data that support the findings of this study are available from [International Bamboo and Rattan Organisation (INBAR)] but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of [INBAR].

- **Competing interests**

The authors declare that they have no competing interests

- **Funding**

The International Bamboo and Rattan Organization (INBAR) conceived the Project and lunched for research consultancy. Provided the funds for data collection.

- **Authors' contributions**

BNN Conceptualized, investigated, and drafted original manuscript for this stusdy, EK superved, interpreted data and was major contributoe in reviewing the manuscript, KR Conceptualized, Reviewed, and provided fund for the study; CDC investigated, coded data, review & edited the rattan manuscript; GWF investigated, reviewed & edited the manuscript; NPA investigation; and was major contributor in analyzing, interpreting and reviewing draft and TAD investigated, and draw maps for rattan distribution All authors read and approved the final manuscript."

- **Acknowledgements**

Authors extent their gratitude to the International Bamboo and Rattan Organisation for funding the field study. Authors thank immencely FOKABS Cameroon for implementation of this project and making use of the authors. Gratitude is also extended to all independent reviewers for their academic support towards strengthening the scientific writing to meet international standards.

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Figures

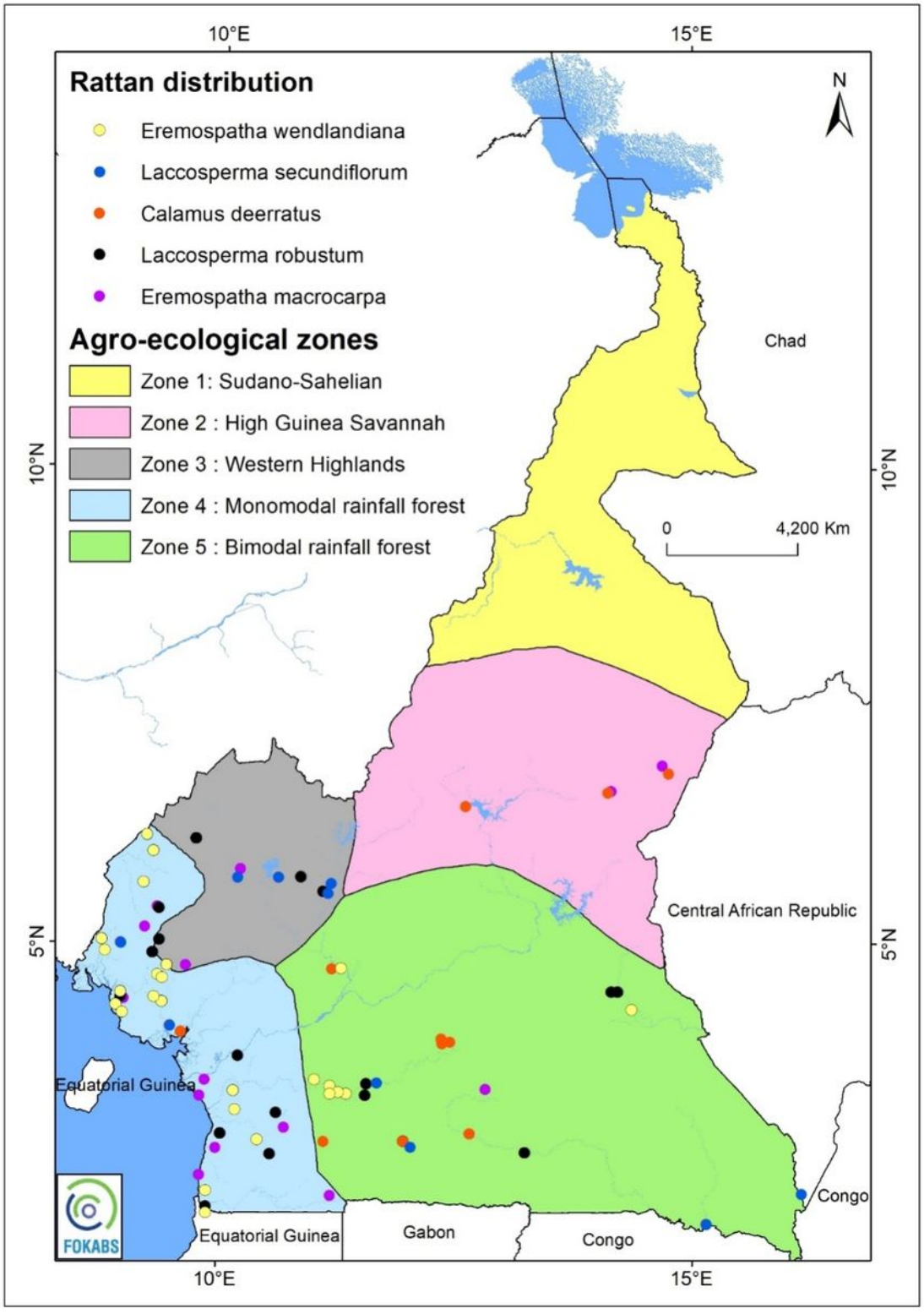


Figure 1

Map of distribution of economically important rattan species in Cameroon