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SHORT COMMUNICATION – FOREST MANAGEMENT

African Mahogany Plantation Highlights in Brazil

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Abstract

African mahogany is the common name of species from the *Khaya* genus and yields high value timber. It is planted in monocultures and agrosilvipastoral systems in Brazil since the 90's. Here we relate the taxonomic identification of the most planted African mahogany species in Brazil, changing from *Khaya ivorensis* A. Chev. to *K. grandifoliola* C. DC. Currently we estimate there is circa 50 thousand hectares of plantations in Brazil, half concentrated in the Southeast region, with the most planted species *K. grandifoliola*, followed by *K. senegalensis* (Desr.) A. Juss.

Keywords: *Khaya grandifoliola*, *Khaya ivorensis*, *Khaya senegalensis*, Taxonomic identification, high-value timber species.

Planning and achieving sustainable forest resource management provides a fundamental contribution to reduce societies' environmental impacts, and enhances the supply of forest products (FAO, 2019). In this sense, one genus that has gained interest among Brazilian foresters is *Khaya*, which contains all the species commonly known as African mahogany. This genus includes some of the highest-value timber species in African forests, which are under heavy exploitation pressure and listed as vulnerable by the IUCN (Pakull et al., 2019).

African mahogany wood from native African forests is consolidated in the international timber trade, being employed for several high-end applications, such as furniture, sawnwood and veneers. While the majority of the commercially traded wood is originated from native African forests (ITTO, 2021), small scale use of wood from Brazilian plantations from few older plantations (circa 20 years old) as well as from thinning (circa 8 to 12 years old) have recently been applied with success for several uses, such as sawnwood, veneer faces, designer furniture and musical instruments (Ribeiro et al. 2019).

According to Ribeiro et al. (2017), the history of African mahogany in Brazil began in the 70's, when a researcher from Embrapa Amazônia Oriental received seeds from government officials from the Ivory Coast. These seeds were planted in Embrapa's headquarters in Belém, Pará. Currently four of these trees still exist (from here on referred to as genotype trees), three of them individuals of excellent form and size. In the 90's these trees began producing seeds, which were used to produce seedlings stock for new plantations, mainly in the North region. It was determined at this time that these trees belonged to the species *K. ivorensis* A. Chev.

After these plantations started producing seeds, the plantation area of African mahogany expanded beyond the North to the other regions of Brazil, facilitated by the availability of seed lot and cloning techniques (e.g. Barroso et al., 2018) for seedling production. Although other African mahogany genetic material was imported from Africa during this time, the genotype trees and its descendants where the main provider of genetic material of most African mahogany plantations in Brazil, excluding *K. senegalensis* (Desr.) A. Juss.

The fact that the genotype trees were incorrectly identified as *K. ivorensis* was raised in 2013, by comparing material from plantations with exemplars from the experimental plots of the Reserva Natural da Vale (RNV), located in the municipality of

Sooretama, Espírito Santo State, Brazil. In 2015 Dr. Terrence Pennington (Kew Royal Botanic Gardens) received herbarium specimens from the genotype trees and from RNV, classifying them as *K. grandifoliola* and *K. ivorensis*, respectively. In 2019, by the invitation of the Brazilian Association of African Mahogany Producers, Dr. Gaël U. D. Bouka visited in loco the genotype trees and other plantations and confirmed that the specimens belonged to the species *K. grandifoliola*, and not *K. ivorensis* as previously classified. This conclusion was reached primarily due to morphological differences of *K. grandifoliola* leaflets compared to other *Khaya* species, namely: presence of prominent secondary veins; basal leaflets with a generally oval lamina, sometimes ovato-oblong, smaller than the other leaflets; terminal leaflets (4.5–) 5.5–8.0 (–10.5) cm wide; (7) 10 to 14 (20) pairs of secondary ribs.

We evaluate that most of the research that was published citing *K. ivorensis* from Brazilian plantations prior to 2019 were related to *K. grandifoliola*. The following works we are certain that studied *K. grandifoliola*, and not *K. ivorensis* as reported: Ribeiro et al. (2016; 2017; 2018a; 2018b); Mayrinck et al. (2018); Oliveira et al. (2018). While we are fairly sure – given the location mentioned on the Materials – of other research papers that report findings of *K. grandifoliola* and not *K. ivorensis* (e.g. Zanetti et al., 2017), this is not true in all cases. For instance, research conducted with *K. ivorensis* from the experimental plots from RNV (França et al., 2015) correctly identified the different *Khaya* species located in their plots. Only selected research from late 2019 and 2020 have correctly identified *K. grandifoliola* (e.g. Silva et al., 2019; Soares et al., 2020).

We estimate that the current plantation area of African mahogany in Brazil to be 50,000 hectares, predominantly composed by the species *K. grandifoliola* (66%) and *K. senegalensis* (33%). Other African mahogany species are also planted (*K. anthotheca* and *K. ivorensis*), but on a much smaller scale. These plantations are distributed in the Southeast (50%), Mid-West (25%), North (13%), Northeast (6%) and South (6%) regions of Brazil, and the majority are under 10 years old. The area estimates presented here were made collecting information by reaching out to known African mahogany producers, silvicultural companies and nurseries. As such, the species plantation area provided here should be considered a first nationwide estimate and should be confirmed by alternative sources (i.e. Environmental Rural Registry – CAR).

Species delimitation within the *Khaya* genus is contentious, with the latest revisions recognizing the species: *K. anthotheca* (Welw.) C. DC.; *K. nyasica* Stapf ex Baker; *K. grandifoliola*; *K. ivorensis*; *K. madagascariensis* Jum. & H. Perrier; *K. senegalensis* (Bouka, 2017; Bouka et al., 2019; Pakull et al., 2019). Despite some overlap in their distribution ranges, each *Khaya* species displays restricted ecological requirements along an ecological gradient, from moist evergreen forest to semi-deciduous forest and savanna (Monthe et al., 2018; Bouka et al., 2019).

The morphological proximity in the *Khaya* genus makes species identification difficult, and is nearly impossible when working only with timber material, where *Khaya* can only be identified to generic level using wood anatomical methods (Pakull et al., 2019). These authors conducted a research of genetic diversity and differentiation among the species of African mahogany based on a large SNP array and reported that *K. ivorensis* was very different from all the others, *K. grandifoliola* and *K. senegalensis* comprised a second group; the three species *K. anthotheca*, *K. madagascariensis* and *K. nyasica* represented a third group. Within this third group, *K. madagascariensis* and *K. nyasica* were similar.

When the wood is sourced from native forests, the timber market prefers *K. ivorensis* over the other traded African mahogany species (Pakull et al., 2019). However, studies have shown few differences between the African mahogany species wood properties when plantation grown. For instance, Yeboah et al. (2014) evaluated 5-year-old *K. ivorensis* and *K. grandifoliola* trees in two ecozones in Ghana and found there was only a difference in wood density (a proxy for wood quality) according to the planting location (0.53 g cm^{-3} for wet evergreen versus 0.42 g cm^{-3} for moist semideciduous), and not species. Comparing 19-year-old *K. senegalensis* with *K. ivorensis* wood grown in Brazil, the former has lower wood specific density (0.49 g cm^{-3}), indicated for low to medium mechanical strength requirements, such as furniture production, plywood and surface finish in civil construction. *K. senegalensis* wood, with higher specific density (0.59 g cm^{-3}), is suitable for uses that require greater mechanical strength (França et al., 2015).

Despite the apparent similarities between the different African mahogany species, there are important silvicultural traits that must be further examined. Empirical experiences of over ten years with *K. grandifoliola* and *K. ivorensis* in planted under agroforestry systems in Sucupira Farm (Bahia, Brazil) showed that *K. grandifoliola* presents superior growth over *K. ivorensis*, especially in less productive sites. *K. grandifoliola* has also shown to be more resistant – but not immune – to shoot borers attacks from *Hypsiphylla grandella* than *K. ivorensis*. Stem form of *K. ivorensis* is superior to *K. grandifoliola*. Further studies must be done to confirm if the silvicultural differences between the African mahogany species persists as these plantations become older, are planted in different geographical locations and are grown under different management schemes.

African mahogany plantation area is expected to increase, independent of the species chosen, with possible help

from foreign capital investment and with greater interest from rural producers in the diversification of production, highlighting the greater use of trees in integration systems (e.g. agrosilvipastoral). The insertion of planted African mahogany timber of Brazilian origin in the national and international market is perceived as a successful goal. Also, the precision of the species classification and the extent of the *Khaya* plantations in Brazil and elsewhere give good visibility on the degree of ex situ conservation of the species.

There are still many research gaps that must be explored to guarantee the success of African mahogany plantations in Brazil. Since these plantations are destined for high-value timber production, studies on wood quality and response to management practices (such as thinning and pruning), as well its suitability in agrosilvipastoral systems (e.g. Alves et al., 2020) are warranted.

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