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CHECKLIST OF ORNAMENTAL PALMS IN NIFOR PALMETUM BENIN CITY, NIGERIA

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ABSTRACT

The Nigerian Institute for Oil Palm Research (NIFOR) Palmetum has faced significant challenges, leading to a decline in its ornamental palm species collection. This study presents the first comprehensive checklist of existing ornamental palms, highlighting their health, economic importance and conservation status. Using standard procedures, 231 trees from 22 genera and 26 species of Arecaceae were identified and documented, including their botanical and common names, and native range. *Phoenix* L. showed the highest diversity with 3 species, followed by *Elaeis* Jacq. and *Hyphaene* Gaertn., with 2 species each. The study revealed that 76% of the trees are non-native but have adapted to the region. However, tree health assessment revealed issues like leaf defoliation, galls, stem rots and epiphyte growth, indicating neglect. Beyond their ornamental value, most palms have economic importance as food, feed, fuel and medicine. Given the rapid genetic depletion, urgent conservation measures are needed to prevent biodiversity loss. This checklist will facilitate future palm introductions, *ex-situ* conservation and systematic reproduction of existing species, ensuring the long-term preservation of ornamental palm collection in the Palmetum.

Keywords: Biodiversity; checklist; *ex-situ* conservation; Nigeria; Palmetum

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INTRODUCTION

Botanical gardens are systematically managed collections of living plant specimens, identified by their botanical names, and serve multiple purposes, including scientific research, conservation, education, display and tourism (Oldfield, 2009; Primack *et al*., 2021; BGCI, 2022). These gardens play a crucial role in the *ex-situ* conservation of plant genetic resources, thereby preserving plant biodiversity (Thormann *et al*., 2006). Many botanical gardens specialise in specific plant collections, such as tropical, exotic, herb, medicinal or ornamental plants (Chen and Sun, 2018). Ornamental plants,

cultivated for their aesthetic value, include those used in gardens, landscape design, horticulture and floristry (Oloyede, 2012; Chowdhuri and Deka, 2019). As noted by Jessica (2013), ornamental plants are valued for their decorative appeal, rather than for food, feed or raw materials. Palms, often cultivated as ornamental trees, enhance indoor and outdoor environments, are collected, domesticated and propagated by various institutions and individuals. Botanical gardens encompass diverse types, ranging from ornamental gardens to community gardens, as described by Wyse-Jackson and Sutherland (2000).

In Nigeria, approximately 20 botanical gardens are affiliated with universities and research institutions (Borokini, 2013). Notably, the NIFOR Palmetum is one of the few specialised botanical gardens in the country, dedicated solely to the Arecaceae family (formerly Palmae). With a global distribution of 181 genera and approximately 2600 species across tropical and subtropical regions (Christenhusz and Byng, 2016), this family is extensively represented in the NIFOR Palmetum. Established between 1948 and 1950, concurrent with the founding of the Institute in 1939 (Sparnaaij, 1959), this botanical garden boasts of an unparalleled collection of palms, initiated by the Plant Breeding team in 1948. The collection's broad geographic diversity and large sample size make it a significant resource for scientific research, conservation, display and tourism.

This renowned botanical garden was established with a mandate to promote awareness and appreciation of palm species through interdisciplinary programmes encompassing research, education, conservation, display and recreation. It has been a revered destination for numerous palm enthusiasts, researchers and visitors from within and outside the country, attracting a diverse audience of over 1,000 visitors annually. As of 1970s, the Palmetum's living collections comprised over 500 palm specimens, representing more than 160 species across 25 genera, cultivated on a total area of approximately 6.5 hectares (Obasola, 1971, 1973). This diverse collection has contributed significantly to the understanding, conservation and sustainable utilisation of palm species, aligning with the Palmetum's mission.

Regrettably, the Palmetum suffered a precipitous decline due to neglect and mismanagement, culminating in a state of disrepair. The garden became overgrown with grasses and woody weeds, ultimately transitioning to a secondary forest. The majority of the collections were lost between 1993 and 1997, during a period of industrial unrest at the Institute. Compounding this decline, the combined effects of climate change, inappropriate fire regimes, habitat degradation, pests and diseases significantly depleted the ornamental palm population. Furthermore, the ageing of the living collections and the hapaxanthic growth habit of some palm species have contributed to the decline. This confluence of factors has resulted in the deterioration of this once-exceptional palm collection, underscoring the need for concerted conservation efforts to preserve such valuable genetic resources.

Despite numerous efforts to rehabilitate and preserve the NIFOR Palmetum over the years, the garden's integrity and research potential have yet to be fully restored. Recent initiatives to catalogue and label the existing palm species have yielded limited information on species diversity and composition. To address this knowledge-gap and support a comprehensive biodiversity conservation and regeneration strategy, this article presents a systematic checklist of ornamental palms in the NIFOR Palmetum. The checklist provides essential information on each species,

including botanical and common names, native range, species composition and health status of individual trees, thereby contributing to the conservation and management of this valuable palm collection.

MATERIALS AND METHODS

Study area

The present taxonomic investigation was conducted in the Nigerian Institute for Oil Palm Research (NIFOR) Main Station, situated in Ovia North-East Local Government Area, Edo State, Nigeria (6˚30'N and 5˚40'E), on a campus spanning 1,735 hectares (Figure 1). This region represents the western Nigeria lowland, a relatively flat to gently undulating plain developed on sedimentary rocks and littoral deposits, underlain by tertiary and cretaceous sedimentary rocks primarily composed of sandstones (Ogunkule, 1983). The Palmetum study site, located at the western flank of NIFOR Head Office, occupies a 6.5 hectare land area (16.2% of the total plantation area) in Field 21, designated for the conservation of diverse palm species. The site is surrounded by the Senior Staff Club with picnic facilities, an ornamental palms nursery and a golf course, collectively forming a unique greenspace for recreation and refreshment (Figure 2).

Geographically, the Palmetum is situated within latitudes 06^0 33 36.79N, 005^0 37 03.8E and Longitude 06^0 33 37.26N, 005^0 37 03.80E, at an altitude range of 90 metres -150 metres above sea level. The vegetation is characteristic of the lowland rainforest of western Nigeria, with a bimodal rainfall pattern peaking in June-July and September-October, and an average annual rainfall of 1,595 mm - 2,127 mm. The mean annual temperature is 26.6°C, with temperature minima in August-September (21.9°C and 22.9°C) and maxima in February-March (35.9°C and 34.9°C). The atmospheric relative humidity remains high (86%) throughout the year (NIFOR Meteorological Report).

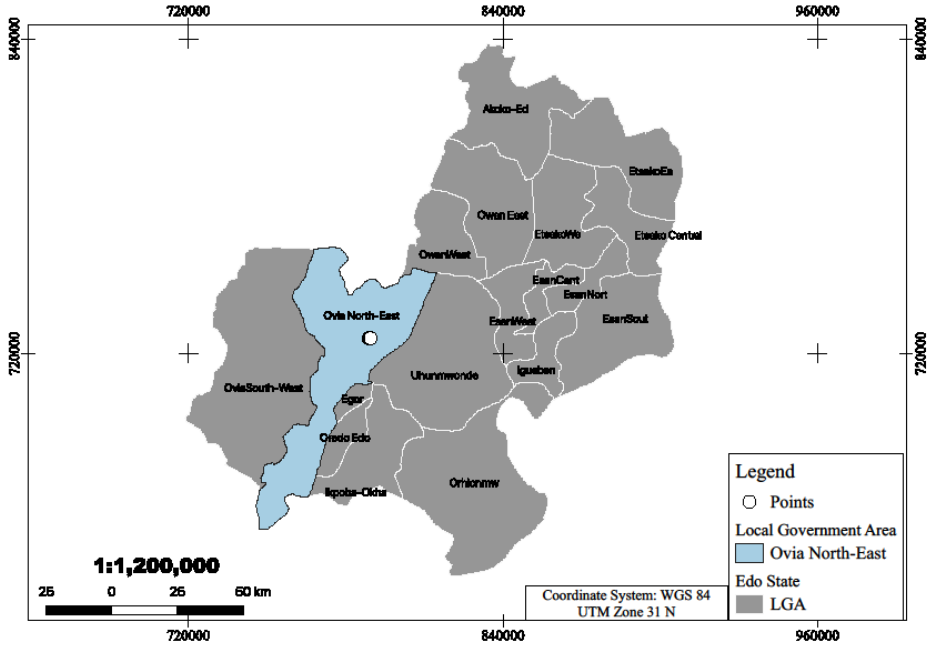

Figure 1: Map of Edo State and Local Government Area where NIFOR is located

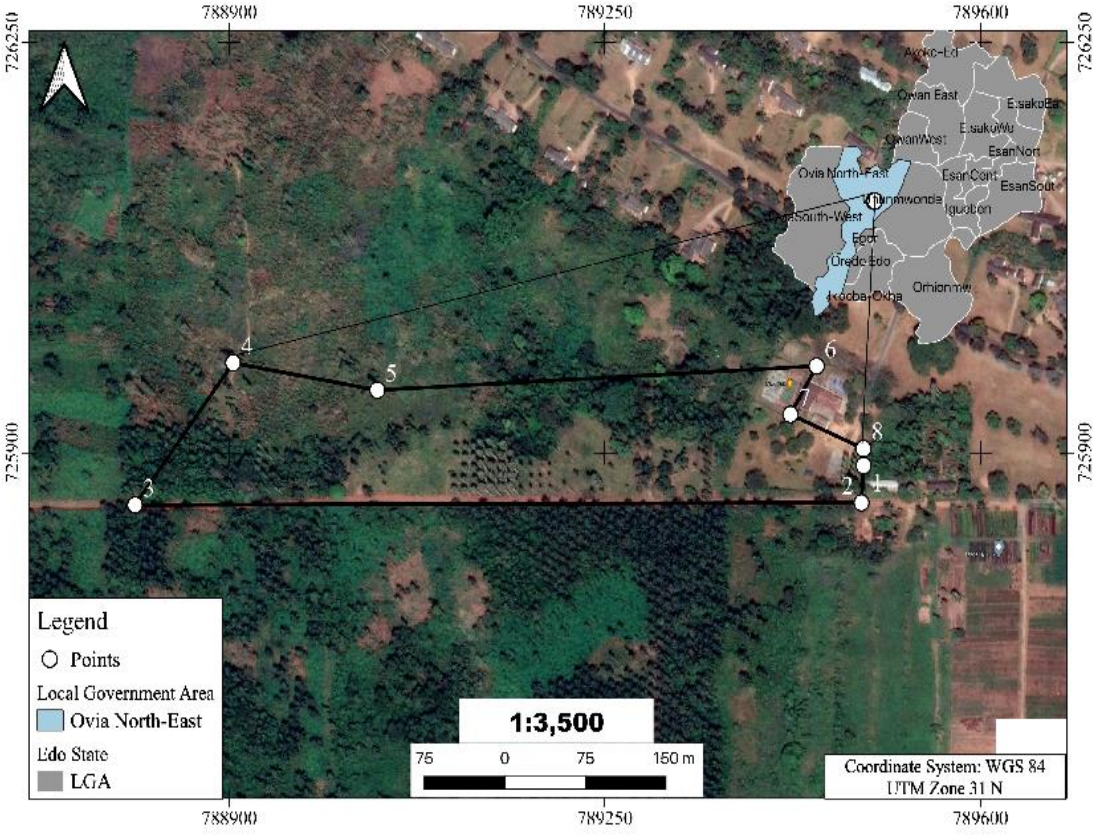

Figure 2: Location map of study area

Species Enumeration

A team of interdisciplinary scientists (Agronomists, Plant Breeders, Pathologists and Soil Chemists) conducted regular field trips to the Palmetum and other garden sections for a period of 10 months from August 2023 to May 2024. During these visits, photographs of palms were taken using a mobile phone camera (Tecno CG6) for documentation and future reference, including the development of an e-herbarium, magazines, newsletters and a photographic descriptive manual. A comprehensive enumeration of trees within the study area was performed through direct counting. Tree identification was done using literature references (Hutchinson and Dalziel, 1972; Uhl and Dransfield, 1987; Keay, 1989; Dransfield *et al*., 2008) available in the NIFOR library. Focus group discussions were held to confirm scientific names and link common names with botanical identifications, following International Plant Name Index (IPNI., 2024) and Plants of the World Online (POWO, 2024) protocols. An annotated list of identified species was documented, including scientific names, common names and native range/origin. Trees' health status was visually assessed based on disease symptoms and pest attacks, ranked using a 1-4 index scale (Olajuyigbe *et al*., 2013): 1. Very good (no symptoms or pests), 2. Good (minor leaf defoliation and low leaf galls), 3. Poor (major leaf defoliation, high leaf galls and epiphyte growth), and 4. Bad (major leaf defoliation, high leaf galls and epiphyte growth, and stem rot). The conservation status of encountered plant species was

assessed following the International Union for the Conservation of Nature (IUCN., 2024) guidelines.

RESULTS AND DISCUSSION

After over three decades of neglect, this study provides the first comprehensive checklist of ornamental palms in NIFOR Palmetum, a crucial step towards revitalising the conservation and research efforts in this important *ex-situ* collection. The study revealed a total of 231 trees, representing 22 genera and 26 species within the family Arecaceae (Tables 1 and 2). Notably, 19 genera (86.4% of the total) are represented by only a single species, which has significant implications for regeneration and conservation efforts in the palm museum (Table 2). This points to the need for strategic seed collection, propagation and planting to enhance the diversity and representation of palm species in the Palmetum. The genus *Phoenix* L. showed the highest diversity, with three documented species (*P. dactylifera, P. reclinata* and *P. canariensis*), followed by *Elaeis* Jacq. and *Hyphaene* Gaertn., with two species each (Table 2). The abundance of *Phoenix L*. and *Elaeis* Jacq. is likely attributed to their research significance as mandate crops of the Institute, emphasising the importance of conservation and sustainable utilisation of palm resources.

Of the 26 species, 76.9% were introduced from various parts of the world, including Africa, the Arabian Peninsula, Australia, South America, Southeast Asia, the USA and the West Indies (Table 1). These exotic collections were primarily sourced from notable institutions such as the Australian Townsville City Council Palmetum, Fairchild Tropical Garden in the United States and a Thai horticulturist, Mr. Watana Sumawong (Otedoh *et al*., 1979). The prolonged introduction of these palms has led to their naturalisation in the region, suggesting the potential for non-native species to become established and potentially invasive. In contrast, only 6 species (23.1%) are indigenous to Nigeria and tropical Africa (Keay, 1989), indicating a significant bias towards exotic species in the Palmetum. The sparse distribution of native species can be attributed to human activities, such as deforestation and neglect, as well as a lack of priority for research and development in the Palmetum (Wardle *et al*., 2004). This underscores the need for conservation efforts to focus on native species and to develop strategies for their preservation and sustainable utilisation.

Table 1: Annotated checklist of ornamental palm species in NIFOR Palmetum.

S/N	Botanical name	Common name	Native range/Origin	No of trees	Composition (%)	Health status	IUCN Status	Economic importance
1	*Acoelorraphe wrightii**	Silver saw palm	Non-native	2	0.87	3	LC	
2	*Archontophoenix alexandrae**	Kings palm/Alexander palm	Non-native	7	3.03	3	LC	Food, medicine & environmental uses
3	*Attalea cohune**	Cohune palm	Non-native	8	3.46	2	LC	Food, feed, medicine environmental uses & fuel
4	*Bactris major*	Peach palm	Non-native	2	0.87	2	LC	Food & medicine
5	*Borassus flabellifer**	Toddy palm	Native	17	7.36	2	NA	
6	*Carpentaria acuminata**	Carpentaria palm	Non-native	1	0.43	1	LC	
7	*Caryota mitis**	Fishtail palm	Non-native	23	9.96	4	LC	Food, fuel, medicine, poison, social & environmental uses
8	*Coccothrinax argentata**	Silver palm	Non-native	2	0.87	2	LC	Environmental uses
9	*Cocos nucifera**	Coconut palm	Non-native	4	1.73	2	NA	Food, feed, fuel, poison, medicine, social & environmental uses
10	*Copernicia prunifera*	Carnauba wax palm	Non-native	6	2.6	2	NA	
11	*Corypha umbraculifera*	Talipot palm	Non-native	12	5.19	2	DD	
12	*Elaeis guineensis**	African oil palm	Native	62	26.84	3	LC	Food, feed, fuel, poison, medicine, social & environmental uses
13	*Elaeis guineensis var. idolatrica**	African oil palm	Native	8	3.46	2	LC	Food, feed, fuel, poison, medicine, social & environmental uses

14	*Hyphaene thebaica**	Egyptian doum palm	Native	10	4.33	2	LC	
15	*Hyphaneae coriacea*	Lala/Ilala palm	Native	4	1.73	2	LC	
16	*Livistona rotunidifolia**	Foot stool palm	Non-native	14	6.06	4	NA	Environmental uses, medicine & food
17	*Oncosperma horridum*		Non-native	6	2.6	3	LC	
18	*Phoenix acaulis*	Dwarf date palm	Non-native	1	0.43	1	NA	
19	*Phoenix dactylifera*	Edible date palm	Non-native	11	4.76	2	NA	Environmental & social uses, food, feed, fuel & medicine
20	*Phoenix reclinata*	Senegal date palm	Native	3	1.3	1	LC	Food, feed, fuel, medicine, environmental & social uses
21	*Prtichardia pacifica*	Fiji fan palm	Non-native	1	0.43	1	NA	Environmental uses & food
22	*Roystonea regia*	Royal palm	Non-native	6	2.6	4	LC	Food, feed, medicine & environmental uses
23	*Sabal palmetto**	Cabbage palm	Non-native	9	3.9	1	LC	
24	*Thrinax radiata**	Florida thatch palm	Non-native	3	1.3	2	LC	Landscaping
25	*Veitchia merilli**	Christmas palm/Manila palm	Non-native	4	1.73	2	NA	Social, environmental uses, medicine & food
26	*Washingtonia robusta*	Mexican fan palm	Non-native	5	2.16	2	LC	Food & environmental uses
				231	100			

Keys: * Flowering and fruiting palms, Tree health status: 1= very good, 2= good, 3= poor, 4= bad; LC – Least Concerned, DD – Data Deficient, NA – Not Assessed

Table 2. Number of species distributed across genera

S/N	Genus	Number of species	Composition (%)
1	*Acoelorraphe* H. Wendi.	1	3.85
2	*Archontophoenix* H. Wendl. & Drude	1	3.85
3	*Attalea* Kunth	1	3.85
4	*Bactris* Jacq. Ex Scop.	1	3.85
5	*Borassus* L.	1	3.85
6	*Carpentaria* Becc.	1	3.85
7	*Caryota* L.	1	3.85
8	*Coccothrinax* Sarg.	1	3.85
9	*Cocos* L.	1	3.85
10	*Copernicia* Mart. Ex Endl.	1	3.85
11	*Corypha* L.	1	3.85
12	*Elaeis* Jacq.	2	7.69
13	*Hyphaene* Gaertn.	2	7.69
14	*Livistona* R.Br.	1	3.85
15	*Oncosperma* Blume	1	3.85
16	*Phoenix* L.	3	11.5
17	*Prtichardia* Seem. & H. Wendl.	1	3.85
18	*Roystonea* O.F.Cook	1	3.85
19	*Sabal* Adans.	1	3.85
20	*Thrinax* L.f. ex Sw.	1	3.85
21	*Veitchia* H.Wendl.	1	3.85
22	*Washingtonia* H.Wendl.	1	3.85
		26	100

The species, *Elaeis guineensis* had the highest distribution of trees (62), followed by *Caryota mitis* (23 trees), *Borassus flabellifer* (17 trees) and *Livistona rotundifolia* (14 trees; Table 1). These four species account for 50.2% of the 231 trees recorded, indicating a skewed distribution of species in the Palmetum. The dominance of *Elaeis guineensis*, an important palm species, is likely due to the research focus of the Institute and its adaptability to the local environment. Beyond the top four species, ten species had between 6 and 12 individual trees, nine species had between 2 and 5 trees, and three species (*Carpentaria acuminata*, *Phoenix acaulis* and *Pritchardia pacifica*) were represented by only one tree each. This distribution pattern reveals a significant decline in species richness and tree composition, suggesting a depletion of the diversity in the Palmetum.

Historically, this Palmetum was renowned for its impressive collection of over 500 trees representing 163 species (NIFOR Annual Report, 1965-1966; Menendez, 1967; Obasola, 1971). However, the current inventory revealed a drastic reduction in population size and species number, likely attributed to poor agronomic management

practices, diseases, pests and environmental factors characteristic of a derelict site. This emphasises the need for conservation efforts and sustainable management practices to restore the past glory of the Palmetum and to preserve the genetic diversity of these charismatic palms.

Although the Palmetum showed low species diversity, several abundant species in the country were conspicuously absent. For instance, various varieties of *Elaeis guineensis* (such as *Deli, nigrescens, virescens, albescens, dura, tenera, pisifera* and *poissoni*) were not represented in the Palmetum. Additionally, other species from the *Elaeis, Phoenix* and *Raphia* genera, including *Elaeis oleifera, Raphia hookeri, Raphia sudanica, Raphia vinifera, Raphia regalis, Phoenix canariensis, Phoenix robellinii* and *Phoenix rupicola* (Obasola, 1971; Otedoh, 1982; Hartley, 1988), were entirely absent from the garden. It is possible that these species may have been overlooked due to their low population levels in the Palmetum or vulnerability to human disturbances. The abundance of these species in the wild highlights the potential for conservation and research efforts to focus on their sustainable utilisation and preservation. NIFOR, as a premier research centre, has the mandate to conserve these palm species, which are not only ecologically important but also have significant economic and cultural values.

Various factors, including anthropogenic activities, adverse weather conditions, injuries, pests and diseases, significantly impact the health status of trees in botanical gardens like the Palmetum (Olajuyigbe *et al*., 2013). Unlike crop species bred for specific environments, ornamental trees are more vulnerable to environmental stresses due to their high aesthetic value. Even minor issues like leaf spots can become major problems in ornamental trees. This study observed common health issues like leaf defoliation, leaf galls, stem rots and epiphyte growth in many Palmetum trees, with termites being the primary pest. The health assessment revealed that only 6.5% of trees were in "very good" condition, while 41.6% were in "good" condition, 33.3% in "poor" condition and 18.6% in "bad" condition (Table 1). Particularly, three exotic palms - *Caryota mitis, Livistona rotundifolia*, and *Roystonea regia* - exhibited severe leaf defoliation, leaf galls, epiphyte growth and stem rot, indicating a "bad" state of health. To prevent the extinction of these species, further research is essential to investigate the pathological status of the living collections in the Palmetum and develop effective conservation strategies.

According to the simplified economic botany data collection standard proposed by Cook (1995), it is noteworthy that the identified palms have multiple economic importance beyond their ornamental value. Many species have various practical uses, including food (*Cocos* sp., *Elaeis* sp., *Phoenix* sp.), feed (*Bactris* sp., *Borassus* sp.), fuel (*Elaeis* sp., *Phoenix* sp.), medicine (*Cocos* sp., Borassus sp.), environmental uses (*Bactris* sp., *Phoenix* sp.) and social uses (*Cocos* sp., *Elaeis* sp.). The most widely represented species with practical uses are *Cocos* sp., *Elaeis* sp. and *Phoenix* sp. However, *Bactris* sp. and *Borassus* sp. are also abundant and provide a variety of palm products, indicating the significance of these species beyond their ornamental value (Otedoh *et al*., 1979).

Interestingly, our survey revealed that 15 species in the Palmetum exhibited significant reproductive vigour, evident from the presence of inflorescence and infructescence. This indicates a high reproductive potential of individual trees in these species, suggesting a strong capacity for dispersal and propagation. However, further

investigations into the reproductive biology of these species would provide valuable insights into their life cycles, pollination mechanisms and seed dispersal patterns, ultimately informing effective management and conservation strategies. Encouragingly, efforts are currently underway to collect mature fruits from the vigorous palms, facilitating large-scale seed germination in the nursery, and replanting of old existing species. The NIFOR ornamental nursery serves as the primary source of ornamental seedlings for the Nigerian public and generates internal revenue for the Institute. It plays a vital role in perpetuating the genetic material of these species, ensuring their continued availability for research, conservation and aesthetic purposes. By exploring the reproductive biology of these species and harnessing their propagative potential, the long-term sustainability of the Palmetum and its contributions to biodiversity, research and the Nigerian public can be ensured.

In accordance with the International Union of Conservation of Nature (IUCN) assessment, results of this study showed that 65% of the palm species in the NIFOR Palmetum are classified as Least Concern (LC), indicating that they are not currently threatened with extinction. However, these species require consistent monitoring to ensure their continued stability. On the other hand, 35% of the palm species, including *Corypha umbraculifera* and other unranked species, are suspected to fall under IUCN threat categories, but lack sufficient data (DD) to confirm their status. This reveals the need for further research and assessment to determine their conservation status. While it is likely that the ornamental palms in the Palmetum are not under immediate threat in the wild, it is essential to develop and implement effective collection, regeneration and conservation strategies to ensure their long-term sustainability. This will not only protect the palms but also support the overall biodiversity and ecological integrity of the Palmetum. By prioritising conservation efforts and addressing data deficiencies, we can work towards ensuring the long-term survival of these species and the ecosystem services they provide.

CONCLUSION

This pioneering study provides a comprehensive inventory of ornamental palms in the NIFOR Palmetum, revealing a concerning rate of genetic depletion among these species. Despite periods of neglect, the Palmetum still harbours a diverse collection of ornamental palms with significant aesthetic, economic and cultural value. Conservation measures are imperative to prevent the extinction of vulnerable species and to mitigate the risk of threatened species. Strict monitoring of the study area is essential to prevent habitat destruction and ensure the success of the on-going NIFOR Palmetum Rehabilitation Project. The systematic reproduction of existing species and introduction of exotic materials are necessary to restore the palm museum to international standards. This checklist will serve as a vital reference for future research and development, providing a foundation for conservation efforts and biodiversity promotion. By prioritising the conservation and rehabilitation of the NIFOR Palmetum, we can safeguard the genetic diversity of these ornamental palms, ensure their long-term sustainability, and preserve their cultural and economic significance for future generations.

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