
A ROLE OF INDONESIAN BOTANIC GARDENS IN ACHIEVING GLOBAL STRATEGY FOR PLANT CONSERVATION GOALS

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ABSTRACT

The Indonesian Botanic Gardens–Indonesian Institute of Sciences (IBGs–LIPI) play a vital role in the world’s plant conservation. By establishing 27 new botanic gardens throughout the Archipelago, in collaboration with local governments and universities, IBGs’ collections conserve plant species from 16 out of 47 ecoregions occurring in Indonesia. IBGs are now accommodating 88,000 or more living specimens from 6000 flowering plant species and conserving at least 24% of the Indonesian native species listed in the global IUCN Red List. The establishment of new botanic gardens in Indonesia has been identified as one of the national priority programs, stated both in the Indonesian Biodiversity Strategy and Action Plan and the Middle-term National Development Plan. By addressing the Global Strategy for Plant Conservation (GSPC) goals and targets by 2020, the IBGs have directly contributed to Targets 1 to 5, 7, 8, 10, 11, and 13 to 16 (Table 1), which are in line with the functions of botanic gardens stated not only in the Indonesian Presidential Decree No. 93 (2011) but also in the Aichi Biodiversity Target.

Key words: Aichi Biodiversity Target, conservation, Global Strategy for Plant Conservation, Indonesian Botanic Gardens.

Botanic gardens have developed and grown through a long tradition of exchanging, studying, displaying, and conserving plants from around the globe. Botanic gardens have not only served as places of serenity and centers for medical and taxonomic research but also played a key role in the historical distribution of useful plants worldwide and the development of national economies (Davis, 2008).

As a home for 30,000 to 40,000 flowering plant species (Widjaja et al., 2014) spreading throughout the Indonesian Archipelago that are facing declination due to various threats, Indonesia now faces a challenging new era of halting plant species extinction. Although a mixture of threats, including habitat loss and degradation, overexploitation, pollution, invasive alien species, and climate change, to in situ conservation continue to grow in number, ex situ conservation strategies and action plans offer promising solutions in synergizing biodiversity conservation strategies. This issue is the main reason we have national strategic plans to establish as many botanic gardens as there are ecoregions throughout Indonesia. With an extensive area and number of botanic gardens as ex situ plant conservation sites, we, hopefully, gain more protected areas with enormous numbers of plant species conserved, including their genetic varieties, as well as more education, public

engagement, and awareness programs available to educate a wide range of people on plant conservation.

Botanic gardens have significant roles in plant conservation globally (Jackson & Sutherland, 2013). This paper will briefly describe the national achievement of the Global Strategy for Plant Conservation (GSPC) targets contributed by the Indonesian Botanic Gardens (IBGs), mainly toward the targets addressing in situ and ex situ conservation, management and sustainable use, public education and community development, capacity building and networking, as well as conservation technique development, as illustrated in Figure 1.

SOME HIGHLIGHTED IMPLEMENTATIONS BY IBGS

Most of the GSPC targets are directly relevant to the work of botanic gardens (Kneebone, 2005). However, the IBGs will directly contribute in at least 13 targets (Table 1), while the remaining targets are of other ministries’ or institutions’ core competence.

OBJECTIVE 1: PLANT DOCUMENTATION AND DISSEMINATION INFORMATION

To support the national plant database, the IBGs have an integrated database of living collections (SIGit), coordinated and centered in the Bogor Botanic Gardens. Plant inventories through botanical

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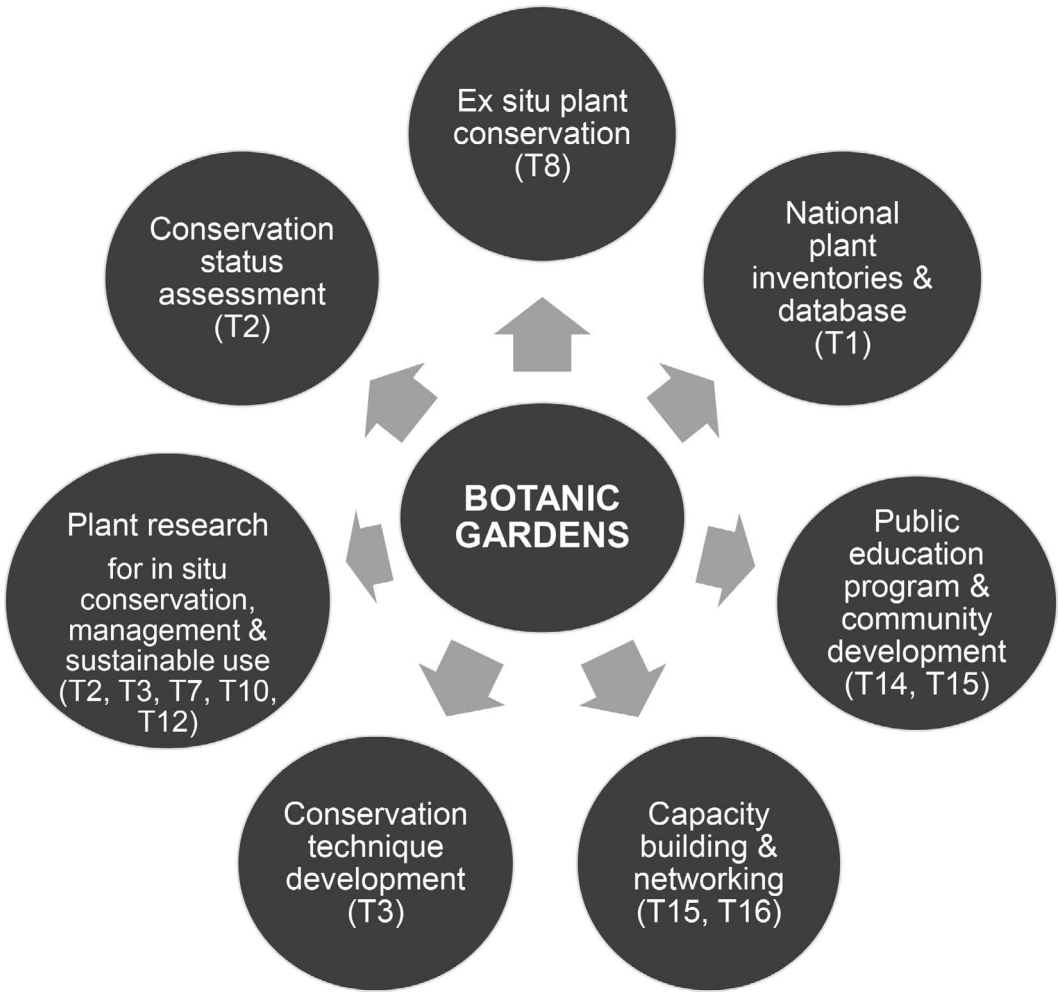


Figure 1. Indonesian Botanic Gardens (IBGs) and the Global Strategy for Plant Conservation (GSPC).

expeditions are still being worked on (dependent on available funding), resulting in new species discoveries, approximately two to 10 species annually.

As the botanical expeditions continue, IBGs are able to check existing population statuses of certain taxa and to assess their conservation status using IUCN Red List Categories and Criteria. We also have developed a method for prioritizing threatened plant species for conservation, resulting in a book series of these prioritized plant species, including ones from *Arecaceae*, *Cyatheaceae*, *Dipterocarpaceae*, *Nepenthaceae*, *Orchidaceae*, and *Thymelaeaceae*.

Here, we highlight efforts of IBGs under the Indonesian Institute of Sciences (Lembaga Ilmu Pengetahuan Indonesia or LIPI) going digital. All of these gardens share web GIS-based information with the public either in the form of a virtual garden, virtual herbarium, or as a virtual navigation system

for smartphones, and have an online catalogue of living collections. The Cibodas Botanic Gardens is developing a digital class, while the Bogor Botanic Gardens is working on a virtual class on plant hybridization and propagation. We also interact with the public through social media for our conservation and education campaign. In addition, we produce popular books about our collections and guidelines for collection management and horticulture as well as brochures and other media describing our programs, research outputs, and the garden's collections. We also have incorporated ethnomedicinal garden-tour routes into our education program to introduce the garden's medicinal plant collection, based on ethnomedicinal data, in a series of practical pocket guidebooks. Regular exhibitions outside the gardens as well as in-house and outreach programs educate a broader range of people. Conservation Strategy and

Table 1. The Indonesian Botanic Gardens' contributions to achieving the Global Strategy for Plant Conservation (GSPC) targets.

Objective I. Plant diversity is well understood, documented, and recognized.		
Significant progress	Target 1. An online flora of all known plants.	The Indonesian Botanic Gardens (IBGs) have developed an integrated database of their living plant collections, namely SIGit (Information and Registry System of Indonesian Botanic Gardens' Plant Collections). All plant records of botanic gardens in Indonesia are stored in an integrated database system managed by the Bogor Botanic Gardens. The Bogor Botanic Gardens has also developed a virtual herbarium for its preserved specimens. Two to 10 new species are discovered annually by IBGs' taxonomy researchers.
Little progress	Target 2. An assessment of the conservation status of all known plant species, as far as possible, to guide conservation action.	Some efforts in updating plant species' conservation status based on the IUCN Red List Categories & Criteria have been initiated by the Bogor Botanic Gardens, Research Center for Biology, Ministry of Environment and Forestry, and Fauna Flora International–Indonesia Program. Since 2008, the IBGs have been working on prioritizing plant species for conservation of selected threatened taxa. Under the Forum Pohon Langka Indonesia, conservation strategy and action plans for 12 endangered native plant species are on the agenda. The Indonesian Plant Red List Authority has also been established.
Little progress	Target 3. Information, research and associated outputs, and methods necessary to implement the Strategy developed and shared.	Sectoral action plans and strategies or guidelines relevant to plant conservation are available. Two conservation strategies and action plans for <i>Rafflesia</i> R. Br. spp. and <i>Amorphophallus titanum</i> (Becc.) Becc. ex Arcang. in 2015 collaborated with the Ministry of Environment and Forestry were published in 2015. Methods in prioritizing plant species for conservation are also published by the Bogor Botanic Gardens to guide conservation action.
Objective II. Plant diversity is urgently and effectively conserved.		
Significant progress	Target 4. At least 15% of each ecological region or vegetation type secured through effective management and/or restoration.	Twenty-seven botanic gardens were established using ex situ plant conservation management in 16 out of 47 ecoregions in Indonesia, representing their local floras of each region. No less than 88,000 species are conserved in IBGs and over 57,000 specimens are managed in the garden's nurseries.
Significant progress	Target 5. At least 75% of the most important areas for plant diversity of each ecological region protected with effective management in place for conserving plants and their genetic diversity.	Up to now, some areas in 16 out of 47 ecological regions occurring in Indonesia have been protected ex situ by establishing 27 botanic gardens covering 4611.5 ha in total.
No progress	Target 6. At least 75% of production lands in each sector managed sustainably, consistent with the conservation of plant diversity.	N/A
Little progress	Target 7. At least 75% of known threatened plant species conserved in situ.	IBGs contributed to species population recovery programs in some conservation areas (national parks and nature reserves) in Sumatra and Java. Nine species were reintroduced to their natural habitats: <i>Pinanga javana</i> Blume, <i>Calamus manan</i> Miq., <i>Alstonia scholaris</i> (L.) R. Br., <i>Parkia timoriana</i> (DC.) Merr., <i>Intsia bijuga</i> (Colebr.) Kuntze, <i>Diospyros macrophylla</i> Blume, <i>Stelechocarpus burahol</i> (Blume) Hook. f. & Thomson, <i>Vatica bantamensis</i> Benth. & Hook. f., and <i>Heritiera percoriacea</i> Kosterm.

Table 1. Continued.

Significant progress	Target 8. At least 75% of threatened plant species in ex situ collections, preferably in the country of origin, and at least 20% available for recovery and restoration programs.	Only 21% of Indonesian threatened plant species have been conserved ex situ in botanic gardens. However, some efforts have resulted in the recovery of targeted species through reintroduction and population reinforcement activities. Botanical expeditions in line with plant diversity inventories are increasing. Legal aspect: Presidential Regulation No. 93/ 2011 on Botanic Gardens.
No progress	Target 9. 70% of the genetic diversity of crops including their wild relatives and other socio-economically valuable plant species conserved, while respecting, preserving, and maintaining associated indigenous and local knowledge.	N/A
Little progress	Target 10. Effective management plans in place to prevent new biological invasions and to manage important areas for plant diversity that are invaded.	Only one or two research staff members of IBCs are working on invasive plant species, resulting in no management plans in place for best practices. However, the Bogor Botanic Gardens has started a management plan and practices to halt termite invasions of the garden's tree collections.
Objective III. Plant diversity is used in a sustainable and equitable manner.		
Little progress	Target 11. No species of wild flora endangered by international trade.	The Bogor Botanic Gardens is actively involved in quota assessment for trade of the endangered plant species <i>Cyathea contaminans</i> (Wall. ex Hook.) Copel. and <i>Cibotium barometz</i> (L.) J. Sm.
No progress	Target 12. All wild harvested plant-based products sourced sustainably.	N/A
Little progress	Target 13. Indigenous and local knowledge innovations and practices associated with plant resources maintained or increased, as appropriate, to support customary use, sustainable livelihoods, local food security, and health care.	The Bali Botanic Garden has one focus study on Balinese people using local bioresources for management recommendation; the IBCs have a research group studying ethnobotany, but it is still a very limited research project for gaining more comprehensive information about local knowledge and innovations. The Bogor and Bali Botanic Gardens have thematic gardens focused on medicinal properties of plant collections based on ethnomedicinal general practices and include these gardens as part of garden-tour routes for education.
Objective IV. Education and awareness about plant diversity, its role in sustainable livelihoods, and importance to all life on earth is promoted.		
Significant progress	Target 14. The importance of plant diversity and the need for its conservation incorporated into communication, education, and public awareness programs.	Good progress has been made as many public education modules and programs, visitor information centers, and centers of botanic garden information (including libraries) have developed and increased, especially in the botanic gardens under Lembaga Ilmu Pengetahuan Indonesia (LIPI), as well as public outreach programs. Plant diversity and some topics of plant conservation have been incorporated into IBCs' public engagement programs. The GSPC toolkit for Indonesia (guide for implementation, brochures, and web-based information) is being developed by the Bogor Botanic Gardens.

Table 1. Continued.

Objective V. The capacities and public engagement necessary to implement the Strategy have been developed.		
Little progress	Target 15. The number of trained people working with appropriate facilities sufficient according to national needs, to achieve the targets of this Strategy.	Less than 25 people have trained abroad on plant conservation and management, but scholarships for master and doctoral courses for botanic gardens' staff are increasing. Annual trainings for botanic gardens' managers, technicians, and child educators are available, coordinated by the Bogor Botanic Gardens and funded by the central government.
Significant progress	Target 16. Institutions, networks, and partnerships for plant conservation established or strengthened at national, regional, and international levels to achieve the targets of this Strategy.	The Indonesian Network for Plant Conservation (INetPC) is reactivated to engage more GSPC stakeholders at the national level, and the Indonesian Botanic Gardens Community (or Masyarakat Perkeburayaan Indonesia [MAPI]) was established. Some memorandums of understanding between gardens for staff-sharing knowledge and public education were signed between the Bogor Botanic Gardens and Padova Botanical Garden (Italy), Missouri Botanical Garden (U.S.A.), Royal Botanic Gardens, Kew (U.K.), Tsukuba Botanical Garden (Japan), and Royal Botanic Garden Edinburgh (U.K.).

Action Plans for Rafflesiaceae and *Amorphophallus titanum* (Becc.) Becc. ex Arcang. for 2015–2025 were published in 2015 by the Bogor Botanic Gardens in collaboration with the Ministry of Environment and Forestry (Susmianto & Widyatmoko, 2015a, 2015b).

OBJECTIVE 2: CONSERVATION OF PLANT DIVERSITY

Up to now, Indonesia has 27 botanic gardens: five botanic gardens are under the auspices of the LIPI, while others are managed by local governments and universities, spreading across 20 provinces in 16 ecoregions (Table 2). The IBGs have contributed 88,000 or more specimens to living collections and 57,643 specimens to the garden's nurseries, conserving at least 24% of Indonesian native plant species listed in the IUCN Red List, in a total area of 4611.5 ha (Purnomo et al., 2015).

In order to support integrative conservation strategy with in situ conservation, the Bogor Botanic Gardens has reintroduced 10 species to their natural habitats in Sumatra and Java (Table 3).

OBJECTIVE 3: SUSTAINABLE USE OF PLANT DIVERSITY

The Bogor Botanic Gardens is actively involved in quota assessment for trade of the endangered plant species *Cyathea contaminans* (Wall. ex Hook.) Copel. and *Cibotium barometz* (L.) Sm. However, the national focal point of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is not held by the Bogor Botanic

Gardens but by the Research Center for Biology instead.

For indigenous knowledge, the Bali Botanic Garden leads this research field, focusing on the Balinese people using local bioresources, such as food, medicine, religious ceremonials, buildings, etc. Furthermore, IBGs have a research group studying ethnobotany, but still very limited research projects have been conducted to get more comprehensive information about local knowledge and innovations. The Bogor and Bali Botanic Gardens have thematic gardens that focus on medicinal properties of plant collections based on ethnomedicinal general practices and include these gardens as part of garden-tour routes for education.

OBJECTIVE 4: EDUCATION AND PUBLIC AWARENESS

IBGs, and more specifically the Bogor Botanic Gardens, now have an extensive public engagement program that provides a wide range of tools and resources to support and promote the education work of IBGs. We provide teacher training, and through a sponsorship by the Corporate Social Responsibility (CSR) of Sharp Electronics Indonesia together with five different non-governmental organizations (NGOs) working in biodiversity, we have trained 30 high school students as ambassadors of biodiversity to educate people concerning biodiversity conservation. IBGs are visited by ca. 2.5 million visitors annually, with approximately 200,000 school children engaged in school programs, including guided tours, education

Table 2. Indonesian Botanic Gardens in ecological region types.

No.	Botanic garden	Province	Area (ha)	Collection theme/Focus	Ecoregion type	Number of plant collections
1	Bogor	West Java	87	humid lowland plants	West Java rainforests	22,268
2	"Eka Karya" Bali	Bali	157.5	dry highland plants	Eastern Java–Bali montane rainforests	21,171
3	Massenrempulu Enrekang	South Sulawesi	300	Wallacea region flora	Sulawesi lowland rainforests	17,049
4	Kuningan	West Java	172	rocky and Mount Ciremai plants	West Java montane rainforests	16,264
5	Cibodas	West Java	120	humid highland plants	West Java montane rainforests	12,947
6	Purwodadi	East Java	85	dry lowland plants	Eastern Java–Bali rainforests	11,864
7	Banua	South Kalimantan	122.1	Kalimantan medicinal flora	Borneo lowland rainforests	9642
8	Cibinong	West Java	189	Indonesian bioregion plants	West Java rainforests	7595
9	Balikpapan	East Kalimantan	309	Indonesian timber plants	Sundaland heat forests	5699
10	Baturraden	Central Java	142	Java mountainous flora	West Java montane rainforests	5587
11	Wamena	Papua	160	Central Papua mountainous flora	Central range montane rainforests	4998
12	Liwa	Lampung, Sumatera	116	Indonesian ornamental plants	Sumatran montane rainforests	3700
13	Katangan	Central Kalimantan	127	Indonesian fruit plants	Sundaland heat forests	3572
14	Sriwijaya	South Sumatera	100	Sumatera medicinal and wetlands flora	Sumatran peat swamp forests	2067
15	Sambas	West Kalimantan	300	Kalimantan riparian flora	Borneo lowland rainforests	2023
16	Bukit Sari	Jambi, Sumatera	425	Sumatra Lowland flora	Sumatran lowland rainforests	1952
17	Samosir	North Sumatera	100	North Sumatera highland flora	Sumatran tropical pine forests	1845
18	Lombok	West Nusa Tenggara	130	Lesser Sunda plants	Lesser Sunda deciduous forests	1832
19	"Jompie" Parepare	South Sulawesi	13.5	coastal Wallacea flora	Sulawesi lowland rainforests	1781
20	Pucak	South Sulawesi	120	economical value plants	Sulawesi lowland rainforests	1032
21	Bataam	Riau Islands	86	small islands flora	Riau Islands rainforests	305
22	Danuau Lait	West Kalimantan	328	equatorial region plants	Borneo lowland rainforests	0
23	Kendari	Southeast Sulawesi	113	ultrabasic flora	Sulawesi lowland rainforests	0
24	Minahasa	North Sulawesi	186	Highland Wallacea region flora	Sulawesi montane rainforests	0
25	Solok	West Sumatera	112.6	spice plants	Sumatran montane rainforests	0
26	Megawati Soekamoputri	North Sulawesi	221	Lowland Wallacea region flora	Sulawesi lowland rainforests	0
27	Pelalawan	Riau	100	Sumatran peat swamp plants	Sumatran peat swamp forests	0

From Tim Pembangunan Kebun Raya (2013) with modifications to nos. 26 and 27 as per 2016. Gardens with zero collection numbers have just started to progress or may have some plant species in their nurseries.

Table 3. Reintroduced species by the Bogor Botanic Gardens.

Year	Species reintroduced	Family	Location (site)	Number of seedlings monitored
2005	<i>Pinanga javana</i> Blume (Pinang Jawa: Javan palm)	Areaceae	Gunung Halimun Salak NP, West Java	5200
2006	<i>Calamus manan</i> Miq. (Rotan Manau: manau rattans)	Areaceae	Bukit Dua Belas NP, Jambi, Sumatra	670
2007	<i>Alstonia scholaris</i> (L.) R. Br. (Pule/Lame: white cheese wood)	Apocynaceae	Ujung Kulon NP, Banten, Java	1000
2007	<i>Parlita tinoriana</i> (DC.) Merr. (Kedawung: tree bean)	Fabaceae	Meru Betiri NP, East Java	1000
2009	<i>Inisia bijuga</i> (Colebr.) Kuntze (Merbau: Borneo teak/Moluccan ironwood)	Fabaceae	Ujung Kulon NP, Banten, West Java	500
2009	<i>Diospyros macrophylla</i> Blume (Ki Calung)	Ebenaceae	Ujung Kulon NP, Banten, West Java	100
2009	<i>Stelechocarpus burahol</i> (Blume) Hook. f. & Thomson (Kepel: keppel fruit)	Amnonaceae	Ujung Kulon NP, Banten, West Java	400
2014	<i>Vatica bantamensis</i> Benth. & Hook. f. (Kokoleceran)	Dipterocarpaceae	Ujung Kulon NP, Banten, West Java	100
2014	<i>Heritiera percaricea</i> Kosterm.	Sterculiaceae	Ujung Kulon NP, Banten, West Java	50
2014	<i>Diospyros macrophylla</i> Blume	Ebenaceae	Ujung Kulon NP, Banten, West Java	50

packages, and training and research. IBGs have also developed outreach programs for schools, including school gardening and mini botanic gardens.

Approaching its bicentennial in May 2017, the Bogor Botanic Gardens has revitalized its engagement program with communities. Our present focus is on increasing the importance and social relevance of botanic gardens and helping them work with their local communities on common issues of environment, plant diversity, and conservation. These programs are incorporated into the garden's calendar of events and its 200th-year anniversary celebration. We engage a wide range of communities and membership through the garden's calendar of events under the tag line "Plants and People in Harmony." Creating active support for plant conservation by empowering the public through increased knowledge, appreciation, and understanding of plants by the garden's educator staff is a vital aspect of the GSPC. These crucial objectives will not be met without botanic garden educators as key players who can widely spread the message: "Thinking globally, educating locally."

OBJECTIVE 5: CAPACITY BUILDING AND NETWORKING

Target 14 is particularly relevant in that it provides a legislative defense of the validity of education in botanic gardens and highlights its importance in the efforts for plant conservation. Because botanic garden educators are major stakeholders within the biodiversity and conservation education field, building capacity programs for our education staff to deliver inquiry-based science education on the inclusion of plants has also become our concern. For this issue, we have annual training for the staff, funded by the central government. We also carry out teacher training sessions to deliver our conservation messages.

Botanic garden networks around the world are globally linked through Botanic Gardens Conservation International (BGCI). BGCI also supports the Southeast Asia Botanic Gardens (SEABG) Network. By using the spirit of global and regional botanic garden networks, IBGs set up collaborations with botanic gardens abroad to improve staff capacity, knowledge sharing, material exchange, joint fieldwork, and education programs underwritten by memorandums of understanding (MoUs). Such MoUs have been signed with the Padova Botanical Garden (Italy), Missouri Botanical Garden and Fairchild Tropical Botanic Garden (U.S.A.), Royal Botanic Garden Edinburgh (U.K.), and Tsukuba Botanical Garden (Japan). IBGs are now bounded in a community called Masyarakat Perkebunrayaan In-

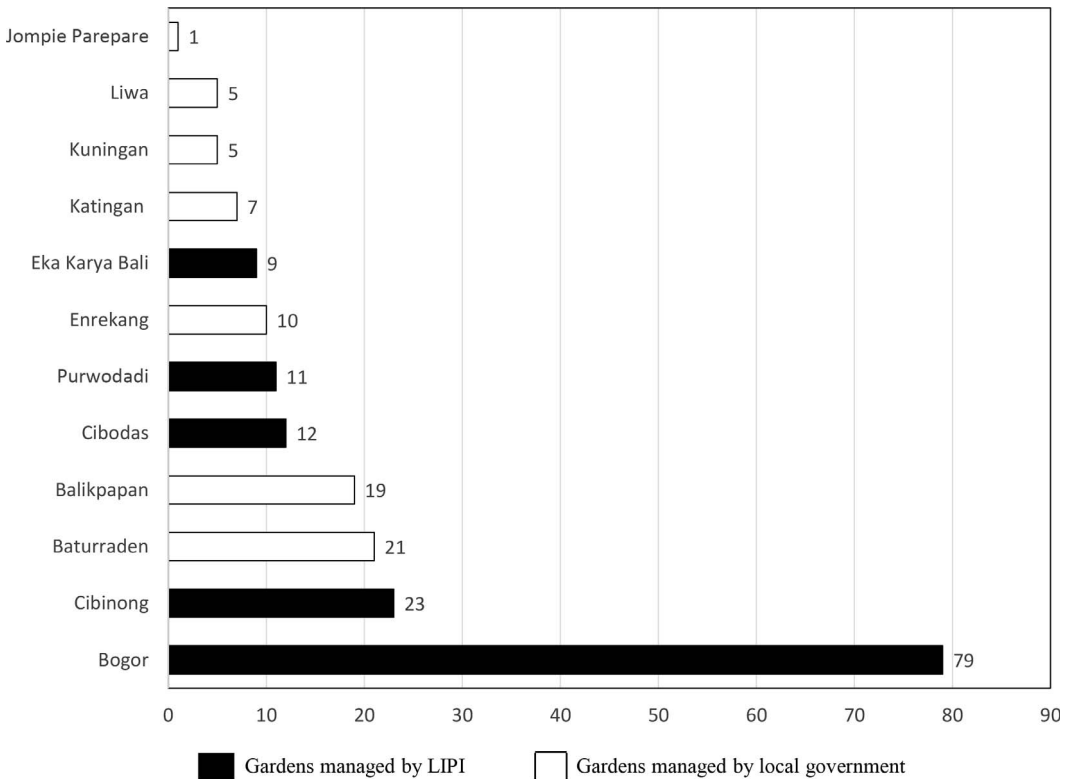


Figure 2. Numbers of threatened plant species conserved in the Indonesian Botanic Gardens (IBGs) (Purnomo et al., 2015).

onesia (MAPI, meaning “Indonesian Botanic Gardens Community”).

Constraints to the national implementation of the GSPC include limited institutional integration, limited sectoral collaboration and coordination, as well as limited financial and human resources and expertise working on plant conservation. Lack of mainstreaming at the planning stage and inadequate guidance such as tools and technology at the operational level also leads to lack of data.

CLOSING REMARKS

The Bogor Botanic Gardens as a part of the IBGs acts as a national focal point for GSPC in Indonesia. The Bogor Botanic Gardens plays a vital role in promoting, reviewing, and coordinating the national GSPC plans and implementation by bringing together stakeholders. This means that implementation success toward GSPC targets relies on partnership and communication between botanic gardens and their stakeholders. By establishing new botanic gardens throughout the country, some targets of the GSPC have been achieved significantly, while some targets implemented by other sectors lack data and infor-

mation. However, with regard to the circumstances and geographic characteristics of such a large archipelago country like Indonesia, the new botanic gardens’ establishment and development leads to significant achievement of Target 8.

With the key challenges for plant conservation identified, it should now be possible for the IBGs to focus on enhancing the GSPC implementation up to 2020 and beyond. Gardens also need to demonstrate to governments how vital their contributions are toward implementation of the GSPC’s goals and the Convention on Biological Diversity’s (CBD) objectives as a whole, in order to get sustainable support for their work. In addition, IBGs should continue their networking to create more mutual partnerships.

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