Status of forest genetic resources conservation and management in Indonesia

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Introduction

Indonesia is an archipelago consisting of about 17 000 islands with a total forest area of 120.3 million ha, covering more than 60% of the country's land area. From an ecosystem point of view, Indonesia can be classified into seven vegetation zones ranging from beach forest, peat forest, mangroves, low land tropical rain forest and savannah to montane and alpine forest.

Many Indonesian people depend on forest resources for their subsistence and customary activities. Forests also generate employment as well as business opportunities. Of the total population of about 206.6 million, an estimated 36 million Indonesians rely on the forests for their livelihood either formally (e.g. industry) or informally (e.g. forest-fringe communities) (MOF 2002).

Two distinct forms of forest resource management can be detected in Indonesia. Forests in Java consist predominantly of teak plantations, while natural forests of the outer islands are more diverse and contain a mix of commercial species varying between regions. For example, dipterocarp species predominate in Kalimantan and Sumatra; *Diospyros* species predominate in Sulawesi, *Eucalyptus* in the Moluccas, and *Pometia, Agathis* and *Araucaria* species in Irian Jaya.

Teak plantation forests in Java were first established under the Dutch colonial rule. Today these forests are managed by Perum Perhutani, a state-owned enterprise that controls a forest area of about 3.2 million ha. Because of differences in area and characteristics of biodiversity, natural rain forests of the outer islands need a very different approach to forest management compared to the plantation forests in Java. A selective cutting system, known as TPI ('Tebang Pilih Indonesia') was introduced in the beginning of the implementation of a forest concession holding system called 'Hak Pengusahaan Hutan' (HPH) in order to ensure the sustainability of timber production.

Forest genetic resources (FGR) are considerably important for Indonesia, as shown by the designation of conservation forests. These forests account for approximately 17% of Indonesia's total forest area, and together with protection forests form a total protected area of 54 million hectares, or roughly 45% of the total forest area. Considering the inherent characteristics of conservation forests, the government has taken various measures to secure them by law. Several legal instruments have been put into effect, and various planning frameworks have been developed through national initiatives as well as through cooperation with international partners. The government has also recognized the value of Indonesia's protected areas that are of particular global importance. This is shown by the support that the government has given for the designation of biosphere reserves by UNESCO.

Conservation of FGR

State of forests and threats to the genetic diversity of species

Indonesia's forest area of 120.3 million ha is divided into four different categories of uses and functions (MOF 2001). These include:

- Production Forests (58.26 million ha)
- Protection Forests (33.5 million ha)
- Conservation Forests (20.5 million ha) and
- Convertible Forests (8.01 million ha)

Forest resources were adversely affected by the economic and social crises in the late 1990s. Based on data provided by the Ministry of Forestry (MOF 2001), forest degradation rate reached 1.6 million ha per year. Among the 120.3 million ha of forest areas, at least 23.9 million ha are degraded and need to be rehabilitated. Illegal logging and timber trade, forest fires, and forest encroachment are among the causes of forest degradation and consequently may threaten genetic diversity of species or even lead to extinction of some species. A number of commercial species have been reported to be under different degrees of threat of extinction (BAPPENAS 2003). For example, *Gonystylus bancanus* (ramin) has been included in the Appendix III of CITES and the distribution of *Eusideroxylon zwageri* (ulin), *Santalum album* (cendana) and a number of dipterocarp species has become narrow. Newman *et al.* (1999) stated that at least 267 dipterocarp species could be found in Kalimantan alone. However, only some of these species have been used. The same authors have suspected that many of the lesser-used species might have become extinct because of human activities.

Overview of the current FGR conservation activities

Conservation of genetic resources is an important part of the Indonesian forest policy. A number of legal measures have been put into effect as the basis for implementation of FGR conservation activities. In addition to the legal instruments, Indonesia's Biodiversity Action Plan (1993) has been used as a guide for natural resource conservation schemes such as: (1) *In situ* conservation in terrestrial parks and protected areas, (2) *In situ* conservation outside the protected area network, (3) Coastal and marine conservation and (4) *Ex situ* conservation.

Ex situ conservation activities have been carried out, for example, by establishing botanical gardens and arboreta. Seventeen botanical gardens have been established in Indonesia (BAPPENAS 2003). Among others, Bogor Botanical Garden in West Java, Purwosari Botanical Garden in East Java and the Bali Botanical Garden conserve plant germplasm from forests. The botanical gardens and arboreta play an important role in public education and in raising public awareness.

Ex situ conservation is also an integral part of tree improvement activities. This includes genebanks for seed and pollen, clonal banks, breeding populations and cryopreservation. For example, Perum Perhutani, a state-owned forestry enterprise, has established conservation stands for various teak varieties collected from all geographical areas in Indonesia since 1998. The Centre for Forest Biotechnology and Tree Improvement Research and Development (CFBTI) has an *ex situ* conservation programme as part of tree improvement activities for some tree species (*Acacia mangium*, *Eucalyptus pellita*, *Paraserianthes falcataria*, and *Melaleuca cajuputi* subsp. *cajuputi*) since the early 1990s. Later, the CFBTI also started *ex situ* conservation of some other species, such as *Santalum album*, *Tectona grandis, Eusideroxylon zwageri, Araucaria cunninghamii, Alstonia* sp., and *Artocarpus altilis.* Furthermore, *ex situ* conservation plots for a number of dipterocarps were already established in Java during the 1950s by the Centre for Forest and Nature Conservation Research and Development (CFNC).

Relevant natural resources management policies and their implementation

Management, utilization and conservation of Indonesia's forest resources are based on the Forestry Act of 1999. The Act also gives specific reference to maintaining production forests, protection forests and conservation of flora and fauna. Another related set of regulations is the Conservation of Living Resources and Their Ecosystems Act 1990. However, land use conflicts with other development sectors are often unavoidable; for example, the importance of conserving the remaining natural forests (especially protection forests and conservation forests) on one hand, and the need to utilize the other natural resources such as mineral deposits and geothermal energy on the other. These two natural resources are mostly located within protection forest or conservation forest areas.

With the commencement of the UU (Undang-Undang) Act No. 22/1999, most development sectors had to initiate a decentralization process. Under the Government Regulation (Peraturan Pemerintah/PP) No. 25/2000, district level governments have been given the authority to regulate and manage their own natural resources. Within the forestry sector, efforts for decentralizing parts of the authority in forest management to district level governments have been made since 1994 through the Minister of Forestry Decree No. 86/Kpts-II/94. The authority for five forest management activities was given to the district governments; these include afforestation and soil/water conservation, silk moth- and bee cultures, private forests, and forestry extension. Moreover, through PP No. 62/1998, the management of 'Taman Hutan Raya' (Provincial Park) and forest gazettements was decentralized to the provincial governments whereas the district governments received the authority for five additional forestry activities, including management of protection forests, non-timber forest products (NTFPs), traditional hunting of unprotected fauna, forest protection and forestry training for local communities.

The area of tropical rain forest in Indonesia has decreased considerably during the past decades. Illegal logging, forest fires and improper implementation of the Forest Land Use Change Policy are among the causes of the current problems in the forestry sector. It has been estimated that there is approximately 23.9 million ha of degraded forest land in Indonesia, distributed in the six major islands; Java, Sumatera, Sulawesi, Kalimantan, Irian Jaya and Maluku (MOF 2001).

In an effort of restoring the productivity of forests and preventing their further degradation, the Ministry of Forestry (MOF) imposed a *selective moratorium on logging* and *gradual reduction of annual allowable cut (soft landing policy)*. Furthermore, for the next 20 years the forest policy in Indonesia will be focusing on securing the tropical rain forest through rehabilitation of the degraded forest areas and conservation of the remaining forests. Rehabilitation in this context refers to all planting activities as stated in the Forestry Act (UU No. 41/1999), Article 41, which is intended to restore, protect and to improve forest functions, so that the carrying capacity, productivity and the role of forest as a life support system could be retained. For the next five years (2003–2007), approximately three million ha of degraded forest and land would be rehabilitated through a national programme called 'Gerakan National Rehabilitasi Hutan dan Lahan' (National Actions on Forest and Land Rehabilitation).

In addition, to improve the management of natural production forests, the MOF has introduced the criteria and indicators (C&I) for sustainable management of natural production forests as a compulsory measure since enacting the Ministerial Decrees No. 4795/Kpts-II/2002 and 4796/Kpts-II/2002. The Decree No. 4795 sets the criteria and indicators for sustainable production forests, while the Decree No. 4796 consists of a procedure for the evaluation of the performance of sustainable production forests at the management level. This is a major shift in the Indonesian forest policy in addressing the problems of unsustainable practices in managing natural forests. The voluntary measures, e.g. timber certification, where private companies implement C&I for sustainable forest management (SFM) for the purpose of meeting the requirements of timber importing countries, continue to be applied. In other words, the compulsory C&I for SFM is the liability of the companies to the MOF, while the voluntary C&I is a means for forest companies to improve their performance in the international market.

Past and present activities in conservation, utilisation and management of FGR

Agroforestry

Agroforestry has long been practiced in Indonesia, particularly in teak plantations in Java since the Dutch colonial era, and has developed from simple systems, such as *taungya* to complex agroforestry systems. Nowadays, an agroforestry system can be a form of collaborative management in a state land, or a form of private land management where settlers cultivate their land by applying an inter-cropping system. There is no exact data

on the extent of these practices; however, some examples have shown positive impacts on the increasing participation of rural community in managing natural resources in an environmentally friendly manner.

Two examples of agroforestry practices on state land can be taken from the districts of Nusa Tenggara and Krui (Sumatera Island). In Nusa Tenggara, the local community practices agroforestry using major commercial plantation species, such as *Tectona grandis* (teak), *Swietenia* spp. (mahogany), and *Paraserianthes falcataria* (sengon), where forest tree species account for 71% of the total species composition (Roshetko and Mulawarwan 2001). People in Krui, West Lampung have carried out biodiversity conservation activities by growing *Shorea javanica* (damar mata kucing) and other tree species producing fruits and other NTFPs such as *Lansium domesticum, Durio zibethinus*, *Parkia speciosa*, *Phitelobium piringa*, *Artocarpus integer* and *Artocarpus* spp. among others.

Other forms of agroforestry practices can be found in Jambi (Sumatera Island) and Gunung Kidul (Java Island). The members of the rural community in Sungai Telang, Jambi use their lands for growing trees and cash crops, while the surrounding forests are only accessed for collecting limited amount of NTFPs. In Gunung Kidul, growing trees on private lands has been practiced since the 1930s and has contributed positively in improving the livelihoods of the rural poor.

Afforestation and reforestation

Afforestation (planting of trees and perennial plant species on non-forest lands) is a government programme that has been carried out since the 1970s. Currently available data on the total afforested area only covers three years of activities from 1999, which indicates that about 532 664 ha of degraded non-forest land was afforested during the three years through development of small-scale plantations, provision of nurseries at the village level (Kebun Bibit Desa) and land rehabilitation activities (MOF 2002).

Reforestation (planting of trees and perennial plant species on degraded forest land) is also a government programme that has been implemented since the 1970s. There is no complete data available on the total area reforested, it has been estimated that a total area of 85 910 ha has been reforested during the five years from 1997 to 2001 (MOF 2002).

Forest plantations

Establishment of forest plantations (or industrial plantation forests – Hutan Tanaman Industri, HTI) started in the early 1980s in the outer islands. At that time a target of 6.2 million ha of HTI by the year 2000 was set. However, several factors such as lack of land suitability assessments, limited availability of genetically improved seed, insufficient technical knowledge and experiences in commercial timber plantations on the outer islands contributed to the low achievement level of the HTI programme. Reliable data on the achievements of the programme is lacking. However, based on information gathered from a number of timber plantation companies (HPHTI holders), approximately one million ha of HTI using fast-growing species such as *Acacia, Eucalyptus, Paraserianthes, Gmelina* has been successfully established, mainly for producing raw material for pulp and paper. Plantations of the state-owned enterprise Perum Perhutani in Java, consisting of teak and other tree species cover about 1.8 million ha.

Demand and supply of tree seed

One of the obstacles in plantation establishment has been the limited supply of seeds and planting materials, both in quantity and quality. As each species or species group has specific characteristics in seed production and dispersal, providing planting materials at the right time and in sufficient amounts becomes very difficult.

Estimating the supply and demand of tree seed is another challenge at the current stage because of various reasons. The Directorate General of Land Rehabilitation and Social Forestry, MOF has estimated annual seed production for planting and seed production. However, as there is no information on the purpose of plantations or the use of seeds (e.g. commercial plantation, private forest, afforestation, reforestation or conservation) this information still needs to be updated in the near future.

In situ conservation

Indonesia is one of the first tropical countries in the world to create a protected area system, which includes *in situ* conservation efforts. *In situ* conservation is mainly designed to protect ecosystems or natural habitats. By the year 2001, Indonesia has established 399 terrestrial and marine conservation areas, which account for 22.5 million ha in total (see Table 1). Furthermore, 692 protection forest areas have been established, which cover approximately 34 million ha (MOF 2002).

Table 1. Status of conservation areas in 2001 (MOF 2002)

Type of conservation area	Terrestrial conservation		Marine conservation	
	Units	Area (1000 ha)	Units	Area (1000 ha)
Nature reserves	175	2354.3	8	211.3
Wildlife sanctuaries	47	3517.5	3	65.2
Nature recreation parks	81	281.2	14	668.9
Hunting parks	15	247.4	–	–
National parks	34	11 069.4	6	3681.4
Grand forest parks	16	332.5	–	–
Total	**368**	**17 802.3**	**31**	**4626.8**

In addition to the conservation activities in the allocated areas, a number of genetic resource conservation areas, called Areal Sumber Daya Genetic (ASGD) have been assigned by forest concession holders (HPHs). This is a compulsory measure imposed by the government in order to secure seed supply for plantation establishment as well as for enrichment planting purposes. Under this policy, each HPH is required to allocate 100 ha as seed stands in each five-year plan. In addition to the 100 ha of ASDG, the HPHs are also required to assign an area of 100–300 ha for germplasm conservation. The target species for these activities include: (a) tree species from endangered populations, (b) tree species with a low regeneration capacity, and (c) tree species that are scarce in their natural habitats. These two approaches to *in situ* conservation have been found ineffective because: (a) the two policy measures are not clearly understood by HPH personnel, (b) further elaboration of the policy measures to guide their implementation on the ground has not been carried out and (c) there has been a lack of monitoring and evaluation of the implementation of the two policy measures.

In an effort to sustain the genetic resources of commercial species, the Minister of Agriculture issued the Decrees No. 54/Kpts/Um/2/1972 and No. 261/Kpts-IV/1990, which set a minimum cutting diameter for a number of important species. The species are not allowed to be cut before reaching the minimum size determined in the Decree (Table 2).

Table 2. Lists of tree species protected under the Decree No. 54/Kpts/Um/2/1972 (the species are allowed to be cut only after reaching the minimum size determined)

No.	Scientific name	Local name	Minimum cutting diameter (cm)
I.	**Resin producing tree species**		
1	*Palaquium gutta*	Balam merah, Sumban	50
2	*Agathis labillardieri*	Damar, Kopal	50
3	*Dyera* sp.	Jelutung	60
4	*Palaquium leiocarpum*	Hangkang	30
5	*Dryobalanops camphora*	Kapur banis	60
6	*Styrax* sp.	Kemenyan	30
7	*Dipterocarpus* sp.	Keruing (minyak)	50
8	*Ganua motleyana*	Ketiau	30
9	*Shorea* sp.	Mata kucing (damar)	60
II.	**Fruit tree species**		
1	*Palaquium walsurlfolium*	Balam suntai	40
2	*P. burckii*	Jambu monyet	30
3	*Durio zibethinus*	Durian	60
4	*Aleurites moluccanus*	Kemiri	50
5	*Arenga pinnata*	Enau	40
III.	**Tree species with its useful bark and/or natural colour substance.**		
1	*Excoecaria agallocha*	Mata buta, garu	25
2	*Myristica argentea*	Honggi, Saya	30
3	*Cudrania* sp.	Kayu kuning	10
4	*Cinnamomum burmannii*	Kayu manis	25
5	*Caesalpinia sappan*	Kayu sepang	10
6	*Cinnamomum cullilawan*	Kulit lawang	25
7	*Cryptocarya massoy*	Massoi	25
IV.	**Tree species with one or more specific values, such as bark, wood, or essential oil**		
1	*Pterospermum* sp.	Bayur	30
2	*Eusideroxylon zwageri*	Bulian, Ulin	60
3	*Eucalyptus* sp.	Eucalyptus	40
4	*Azadirachta indica*	Imba	50
5	*Intsia amboinensis*	Ipil	60
6	*Diospyros* sp.	Kayu hitam	60
7	*Timonius sericeus*	Ketimunan	40
8	*Scorodocarpus borneensis*	Kulin, Kayu bawang	50
9	*Cordia subcordata*	Pumasamada	40
10	*Manilkara kauki*	Sawo kecik	45
11	*Dalbergia latifolia*	Sono keling	50
12	*Toona sinensis*	Suren	60
13	*Duabanga moluccana*	Taker, benuang	60
14	*Fagraea fragrans*	Tembasu	50
15	*Santalum album*	Cendana	50
16	*Protium javanicum*	Trenggulun	50

Through the Minister of Forestry Decree No. 261/Kpts-IV/1990, the following 12 species of the genus *Shorea* were added to the list in Table 2. These species were known to produce 'tengkawang fruits' which can be used for various purposes including cosmetics. These are: *Shorea stenopten* and *S. stenoptera, S. gysber, S. pinanga, S. compressa, S. seminis, S. martiniana, S. mexistropteryx, S. beccariana, S. micrantha, S. palembanica, S. lepidota* and *S. singkawang.*

Ex situ conservation

Ex situ conservation activities carried out in Indonesia have two main purposes, one as an integral part of the conservation policy and the other as an integral part of tree improvement activities. *Ex situ* conservation is normally implemented in the form of (a) botanical gardens with the main purpose being public education and raising awareness, (b) arboreta and conservation plots for research purposes and (c) seed banks for various purposes.

The development of botanical gardens in Indonesia started in 1817 through the establishment of Bogor Botanical Garden, covering an area of 87 ha. The species collections for Bogor Botanical Garden are mostly from tropical rain forests. The second botanical garden, Purwodadi Botanical garden was established in 1841 and is located in Malang, East Java, with deciduous forest species as the primary collection. In 1959, the third botanical garden was established in Bali, the Eka Karya Botanical Garden, which possesses a collection of 937 species belonging to 156 families.

Various research institutes have also established arboreta. Under the Forestry Research and Development Agency (FORDA) alone, there are ten research institutes all over Indonesia as well as two R&D Centres located in Bogor and Yogyakarta. Each of these 12 institutions has established at least one arboretum or conservation plot.

The *ex situ* conservation of teak in Java was first initiated by Perum Perhutani in 1980, and by the year 1999 Perum Perhutani successfully completed its effort in establishing *ex situ* conservation of plus trees collected from all teak origins throughout Indonesia.

As part of its long-term research programme, the CFBTI has recently established *ex situ* conservation plots in Gunung Kidul (Java) for *Santalum album* (sandalwood) and *Artocarpus* (sukun). *Ex situ* conservation of *Shorea leprosula* and *Lophopetalum multinervium* is currently in progress under an ITTO-Ministry of Forestry project. The project is implemented by the University of Gadjah Mada, in collaboration with some state-owned and private enterprises (PT. Inhutani I, II, Perhutani, PT. Musi Hutan Persada, PT ITCI, PT. Sari Bumi Kusuma and PT. Dwimajaya Utama). Conservation plots will be established in several locations, such as Carita (Perhutani), Palembang (MHP), Balikpapan (ITCI), Central Kalimantan (Alas Kusuma dan Dwimajaya Utama), Pulau Laut (Inhutani II) and East Kalimantan (Inhutani I).

Tree improvement

Tree improvement activities in Indonesia were started in 1930 by the Forest Research Institute (Lembaga Penelitian Hutan, LPH). Research on the reproductive biology of teak began in 1930–31 and then continued with provenance and variety trials (Coster in Suseno 2001). Suseno (2001) suggested that tree improvement efforts before the 1950s were not effective because of incorrect design and the fact that trial plots were not well maintained. Later on, during the 1960s, tree improvement activities for pine (*Pinus merkusii*) began. For example, the LPH, in collaboration with a seed-related project, established a provenance trial for pine (*Pinus merkusii*) during 1968–1971. Gadjah Mada University is one of the leading institutes in carrying out tree improvement activities, for example, pine and teak improvement was initiated in the 1970s. In terms of species target, Suseno (2001) divided the tree improvement activities in Indonesia into six groups as follows:

1. *Tectona grandis*
2. *Pinus merkusii*
3. *Acacia mangium* and other fast growing species for pulp and paper
4. Non-teak species in Java
5. Dipterocarps and other tropical rain forest species
6. Community forest species

Table 3 depicts some examples of existing tree improvement activities carried out by various research institutes and universities in Indonesia.

Table 3. Status of tree improvement activities carried out by various institutions in Indonesia (Suseno 2001; CFBTI 2003, unpublished)

Species	Provenance test	Progeny test	Clonal test	Seed stand	Seed orchard	Hybrid
*Acacia mangium**	X	X	X	X	X	X
*A. crassicarpa**	X	X			X	
*A auriculiformis**	X	X			X	
A. mangium X						
*A. auriculiformis**						X
*Artocarpus heterophyllus**		X		X	X	
Eucalyptus deglupta	X	X				
E. urophylla	X	X				
E. urophylla x E. alba						X
E. urophylla x E. pellita						X
E. urophylla x E. brassiana						X
E. urophylla x E. grandis						X
E. brassiana		X				
*E. pellita**		X			X	
Gmelina arborea	X	X			X	
*Melaleuca cajuputi**		X				
Morus spp.*			X			
*Paraserianthes falcataria**	X	X			X	X
Pinus merkusii	X	X			X	X
*Santalum album**		X				
Shorea johorensis		X				
S. macrophylla		X				
S. parvifolia		X				
S. pinanga		X				
S. stenoptera		X				
Swietenia macrophylla		X				
S. mahagoni				X	X	
*Tectona grandis***	X (+)	X (+)	X (+)	X	X	
Armelia sp.				X		
Shorea selanica				X		
Gliricidia sp.			X	X		
Aleurites moluccanus					X	
Armeia campaca					X	

Note: * = Carried out by CFBTI and no record available for other institutions
** = Carried out by Perhutani
(+) = Carried out by CFBTI

The CFBTI, as one of the research centres under the FORDA has carried out tree improvement activities for a number of species, for example: *A. mangium*, *Eucalyptus pellita*, *Melaleuca cajuputi, Santalum album, Paraserianthes falcataria*, *Tectona grandis, Araucaria cunninghamii, Morus* spp. and *Artocarpus altilis.* In addition, the CFBTI has also cooperated with private companies, such as PT. Indah Kiat, Inhutani I, II, III, MHP, Tanjung Redep Hutani and PSPI in the establishment of seed orchards (Table 4). A network on tree improvement between the CFBTI and private companies has also been established.

Table 4. Collaborative activities on tree improvement between the CFBTI and forest companies (CFBTI 2003, unpublished)

No	Name of partner	Collaborative activity	Time / period	Location
1	JKLT PT Inhutani I	Establishment of seedling seed orchard (SSO) for *Acacia mangium*: second-generation progeny test	5 years from 2000	PT Inhutani I area in Batuampar, Balikpapan PT. Tanjung Redep Hutani area, Tanjung Redep, Berau. PT. ITCI Hutani Manunggal, area, Kenangan, Balikpapan.
2	PT Inhutani II	Establishment of SSO for *Acacia mangium*	5 years from 2001	PT. Inhutani II area, Sub Unit HTI Semaras, Pulau Laut, South Kalimantan.
3	PT Inhutani III	Provenance trials, progeny tests and establishment of seed orchard Seed supply for establishing SSO for *Acacia mangium* (2nd generation)	1995 2001	PT. Inhutani III area, South Kalimantan
4	PT Indah Kiat Pulp and Paper Tbk.	Establishment of SSO for *Acacia mangium* (2nd generation), *Eucalyptus pellita* and *Acacia crassicarpa* Technical assistance in identification and plantation development of potential local species for pulp and paper	5 years from 2003	PT. Indah Kiat Pulp and Paper area, Siak, Riau.
5	PT Tanjung Redep Hutani	R&D on fast growing species Establishment of SSO for *Acacia mangium* (2nd generation)	1999 2001	PT. Tanjung Redeb Hutani area, East Kalimantan
6	PT. ITCI Hutani Manunggal	Establishment of SSO for *Eucalyptus pellita* Establishment of SSO for *Acacia mangium* (2nd generation)	1996 2001	PT. ITCI Hutani Manunggal area, Suaran, East Kalimantan
7	PT. MHP	Establishment of SSO for *Acacia crassicarpa* (1st generation)	1995	PT MHP area, South Sumatera
		Establishment of SSO for *Acacia auriculiformis* (1st generation)	1996	PT MHP area, South Sumatera
		Establishment of SSO for *Acacia mangium* (1st generation)	1994	PT MHP area South Sumatera
		Establishment of SSO for *Acacia mangium* (2nd generation)	2000	Pendopo, South Sumatera
8	PT. Perawang Sukses Perkasa Industri (PSPI)	Establishment of SSO for *Eucalyptus pellita* (1st generation)	1996	Riau
		Establishment of SSO for *Acacia mangium* (2nd generation)	2001	Riau
		Establishment of SSO for *Eucalyptus pellita* (2nd generation)	2003	Riau

Use of biotechnology for characterisation, improvement and conservation

Biotechnology has been recognized as an important tool in both genetic conservation and tree improvement activities. Use of biotechnology has increased rapidly during the recent years, especially tissue culture techniques for the mass production of planting materials of e.g. *Tectona grandis, Eucalyptus urograndis* and *A. mangium*, are applied by business communities. The use of molecular genetics in forestry is still limited to genetic diversity analysis and marker selection. Some species being studied include *Paraserianthes falcataria, Lophopetalum multinervium, Shorea parvifolia, S. laevis, Eusideroxylon zwageri, Scaphium macropodum* and *Tectona grandis*.

Socioeconomic issues related to the conservation, utilization and management of FGR

Status of forest resources and utilization of trees

Since the beginning of the 1970s, forestry has been playing a unique role as one of the most important development sectors in the country as well as the sector on which development of other sectors depend, for example: agriculture, transmigration, industries, mining, energy/power generation, public work, public health, and tourism (see Table 5). The forestry sector has been the second greatest contributor to Indonesia's foreign exchange earnings, after oil and gas, especially during the early 1990s. Despite this obvious role of forests and forestry as a supporter of other sectors' development, however, up to now there is no formal reciprocal mechanism to guarantee the sustainability of the provision of goods and services by the forests.

Table 5. Development sectors supported by goods and services provided by forest (Wardojo and Masripatin 2003)

No.	Sectors receiving goods and services from forest	Role of forest and forestry
1	Agriculture	Allocation of forest land for agriculture purposes, providing services in the form of watershed protection, erosion control, maintenance of soil fertility and providing genetic resources
2	Transmigration	Allocation of forest land for transmigration programmes, as human settlement and agricultural land
3	Industries	Supply of water and raw materials for both timber and non-timber forest products
4	Mining	Forest areas opened for mine exploration and exploitation
5	Energy/power generation	Water power/energy, geothermal energy
6	Public work	Road construction through forest land, water supply for check dams
7	Public health	Clean water supply, pharmaceutical materials
8	Tourism and other environmental services	Natural beauty, amenity, biodiversity

The forestry sector has played a considerable role in national development for almost three decades since the early 1970s, after the introduction of the HPH. During 1993-1994 forestry sector's contribution to foreign exchange earning increased from US$ 3 billion to US$ 4.2 billion in 1994, ranking second after oil and gas. The sector has also contributed significantly to employment generation. Between the 1980s and 1990s, forestry sector provided 3–4 million labour-years of employment per year in forest management as well as in the industry (Djakaria and Nasendi 1997). Forestry sector also contributed to the national achievement in poverty reduction from 60% in 1970 to 11% in 1996 (World Bank 2000), and the average income per capita increased from US$ 80 in 1967 to US$ 1000 in 1995 (Djakaria and Nasendi 1997).

Timber industries experienced a rapid development for more than a decade, starting from the early 1980s. This development relied heavily on natural forests as the supply of raw materials. For example, the plywood industry grew from 29 mills in 1980 with the total capacity of 1.99 million m^3 per year to 117 mills in 1995 with the total capacity of 13 million m^3 per year (Paribotro 1997). Unfortunately, the rapid development in industry sector was not balanced by improvements in regeneration capacity of the forests. The MOFEC (2000a) stated that the sustainable production capacity of natural forest was only 25.36 million m^3 per year, while the realized consumption reached 58.24 million m^3, resulting in a gap of 32.88 million m^3 between the sustainable supply and realized demand.

The increase in log consumption from 3.2 million m^3 in 1967 to 70 million m^3 in 2000, most of which (± 96 % in 1998) originating from natural forests, could not be balanced

by the existing forests to meet the increasing demand of the timber-based industry. In an effort to restore the productivity and prevent further degradation of natural production forests, the MOF has carried out a restructuring of timber-based industries.

Identification of threats

Forest degradation is one of the major issues that impact the environmental functions of forests. Illegal logging and illegal trade have been serious problems for forestry in Indonesia, especially during the recent years. Forest fires are another challenge that Indonesia is currently facing. Forest fires can be due to either human-induced or natural causes. Some regions are particularly sensitive to catch fire (e.g. Kalimantan's forests that are rich in coal deposits) while in other regions human activities are the main cause, usually as a result of plantation establishment. Fires in 1997/1998 affected an area of about 9.7 million ha, 4.8 million ha of which was forest. Indonesia's National Development Planning Agency (Badan Perencanaan Pembangunan Nasional, BAPPENAS) has estimated that the total economic loss as a result of forest fires reached US$ 9.3 billion. Another potential threat is the illegal trade in non-timber genetic resources, including germplasm.

Identification of invasive species

Invasive species have been suggested in various articles to be a potential problem. However, because of various reasons, including limited resources available, identification of potential invasive species has not been a priority thus far. The available information suggests that *Acacia nilotica* has become invasive in Baluran National Park, East Java.

Links between the forestry sector and FGR

Forest genetic resources are an integral part of the forestry sector. Although there are a number of government institutions dealing with FGR in Indonesia, the MOF is the authority for the management of forest land and resources. Thus, any policy concerning FGR conservation and management cannot be separated from the forestry sector policy.

Links between other sectors: agriculture, agroforestry, animal husbandry and industry

Links between FGR conservation and other sectors: agriculture, agroforestry, animal husbandry and the industrial sector may or may not be clear. Under the current governmental arrangement, agriculture and animal husbandry are under the responsibility of the Ministry of Agriculture, agroforestry is under the Ministry of Forestry and industry is under the Ministry of Trade and Industry. Therefore, the links between these five activities are not very clear unless they are brought under an integrated national programme.

Identification of national priorities

Indonesia is a centre of megadiversity and much of this biodiversity is in its forests, which are a source of famous commercial tree species such as teak and dipterocarps. As there is a large variation among regions in terms of biodiversity level, species characteristics, and social and cultural values, each region has its own priority species to be promoted. For this reason, it is understandable that there is no formal document listing priority species at the national level. A list of priority species for FGR conservation and management is provided in Appendix 1; these species have been identified by various parties in various forums and for various purposes.

Criteria or justification for selecting the priority species

There are two main reasons for genetic investigation of plant species in Indonesia, namely tree improvement and conservation. The priority species listed in Appendix 1 are primarily selected based on one or more criteria, such as their economic, social, cultural and ecological importance and their abundance in their natural habitats. The following selection criteria that were identified in two workshops organized by IPGRI in Lebanon and Syria in 1998 were also considered:

- Associated species
- Ecozones in which the species can be found
- (Potential) socioeconomic value
- Ecological value
- Distribution pattern of the species and its populations
- Distribution pattern of its genetic variation
- Threats imposed on the species
- Conservation status
- Reproductive biology
- Presence or absence of baseline information

Institutional framework for FGR management and conservation

Organizations involved in FGR management and conservation

The main government agencies responsible for genetic resources management and conservation in Indonesia are the Ministry of Environment (MOE), Ministry of Forestry (MOF), Ministry of Agriculture (MOA) and Ministry of Fishery and Marine (MOFM). In addition, a number of other government bodies, such as the Indonesia Science Institute, the State Ministry of Research and Technology and universities conduct research and development addressing major issues in environmental management and genetic resources conservation.

The MOE is the coordinating ministry responsible for the environmental policy and regulations including industrial, transportation, urban and agricultural sectors as well as forest environment. It is also the national focal point for the Convention on Biological Diversity (CBD). Hence, the MOE plays an important role in developing strategies for the conservation of biological diversity and FGR.

The MOF is responsible for the management, research and development of protected areas, while the MOA is responsible for the conservation and utilization of germplasm for agriculture and the MOFM for the conservation and utilization of beach and marine resources. Within the MOF, three agencies are involved:

1. The Directorate General for Forest Protection and Nature Conservation dealing with the management of protected forests and nature conservation
2. The Directorate of Forest Tree Seed under the Directorate General for Land Rehabilitation and Social Forestry for supervision, control and facilitation of the use of good-quality seed for plantation programs
3. The Forestry Research and Development Agency (FORDA) for conducting research and developing and supporting genetic resources management and conservation

Two research centres under FORDA are responsible for R&D activities: the Centre for Forest and Nature Conservation (CFNC) and the Centre for Forest Biotechnology and Tree Improvement (CFBTI).

The CFNC, located in Bogor, is entrusted with the responsibility for carrying out R&D activities in forestry-related topics including silviculture, forest protection (pests, diseases, forest fires, etc), plantation establishment and natural forest management.

The CFBTI, which is situated in Yogyakarta, is entrusted with the responsibility for carrying out research and development activities in biotechnology, population genetics, forest genetic conservation and genetic improvement of major and minor plantation species. The centre is active in setting up genetic resources conservation plots in forms that are suitable for breeding and genetic improvement, such as seed orchards, provenance trials and provenance resource stands, among others. Biotechnological tools, such as molecular markers are used to assist the population genetic diversity studies and understanding of the genetic structure of species of interest. Such information would be critical for the conservation work.

University of Gadjah Mada in Yogyakarta, with the support of ITTO, has been conserving two indigenous species (*Shorea leprosula* and *Lophopetalum multinervium*) since 1998. The major activities of this project include the establishment of conservation plots in Kalimantan, Sumatera and Java, establishment of genetic improvement plots and increasing public awareness on the importance of genetic conservation.

National legislation, policies and strategies on FGR

Some legislation concerning forestry and biological diversity has been enacted. Although most of the legislation does not directly deal with genetic resources, they affect the policy and strategy on utilization, conservation and management of FGR in Indonesia. The following paragraphs provide a brief description of each regulation and policy.

Legislation

Act No. 5/1990 (UU No. 5/1990) on Conservation of Living Resources and Their Ecosystems
In this act, the primary emphasis is on protection efforts, including protection of buffer zones and biodiversity preservation. There is no specific reference to the management of genetic diversity. Under the Act No. 5/1990, conservation areas are divided into (a) *Sanctuary reserves,* which consist of Strict Nature Reserves and Wildlife Sanctuaries; and (b) *Nature conservation areas,* which consist of National Parks, Grand Forest Parks and Nature Recreation Parks.

Environmental Act No. 23/1997 (UU No. 23/1997)
Under the Act No. 23/1997, policy aspects and environmental management of natural and human-made resources, including genetic resources are regulated.

Forestry Act of 1999 (UU No. 41/1999)
UU No. 41/1999 defines a *conservation forest* as a forest area with certain characteristics whose main function is the conservation of biological diversity (flora and fauna) and its ecosystem. *Conservation forests* are divided into three categories according to their main function, namely: (a) Sanctuary reserves, (b) Nature conservation areas and (c) Hunting areas. The Forestry Act of 1999 gives specific reference to the conservation of flora and fauna, although there is no specific reference to genetic resources.

Ministerial Decree (finalization process)
The MOF Decree, which regulates FGR utilization and conservation, tree improvement activities, provision and distribution of forest tree seed, is now in the process of finalization.

Policies and strategies

Designation of specific protected areas with status of international importance

- Biosphere Reserves designated by UNESCO: Gunung Leuser, Tanjung Putting, Lore Lindu, Komodo, Siberut (Taitaibatti) and Cibodas (Gede-Pangrango)
- World Heritage sites: Ujung Kulon National Park, Komodo National Park and Lorentz National Park

Indonesian Biodiversity Strategy and Action Plan (IBSAP) 2003–2020
IBSAP 2003-2020 has recently been released. The following eight points of policy direction for IBSAP implementation have been determined (BAPPENAS 2003)

- Enhance the capacity of communities in managing biodiversity.
- Enhance the assessment and development of knowledge and technology in sustainable management of biodiversity.
- Increase function sustainability and ecosystem balance at the local, regional and national levels.

- Improve the national economy through environmentally and socially sound biodiversity-based technology development.
- Improve the management systems (conservation, rehabilitation, utilization) of biodiversity on a fair and sustainable basis.
- Develop the institutional framework, local and national policies and effective law enforcement in a synergic management of biodiversity.
- Encourage deconcentration and decentralization of central government authority on managing biodiversity to local governments and communities on a gradual and selective manner.
- Develop a mechanism for conflict resolution on natural resources and biodiversity at the local, regional, national and international levels.

Links with other international initiatives

The Government of Indonesia has ratified a number of conventions and other international agreements related to conservation, utilization and management of forest resources. There are three conventions, which have strong inter-linkages in Indonesia's forestry context: (1) the Convention on Biological Diversity (CBD), (2) the United Nations Framework Convention on Climate Change (UNFCCC) and (3) the United Nations Convention to Combat Desertification (UNCCD). Other conventions such as the CITES and the Ramsar Convention on Wetlands of International Importance have also been ratified.

As for other processes, the Intergovernmental Panel/Forum on Forests (IPF/IFF, now the UNFF) has produced a proposal of actions for different forest types. Considering the conditions in different countries and the national sovereignty aspect, each country is to translate these international recommendations to suit the national conditions and development priorities. In the context of Indonesia, the five-year national development programmes (PROPENAS[1]) concerning the utilization of natural resources, emphasize the need to manage or utilize the resources on a sustainable manner. The national programme on natural resource management has been further translated into the sector to suit the priorities and objectives of forestry sector development.

Basically, most of the UNFF recommendations and proposals of actions have already been implemented or followed up by the forestry sector. However, as they have been considered as a part of the sector's development priorities (not necessarily referring to conventions or other international agreements), the efforts have not received international recognition. Such efforts include, for example, the national forest and land use programme, watershed management approach for dealing with areas affected by drought, development of criteria and indicators for sustainable forest management (SFM) as well as management of protected areas.

In order to improve the management, utilization and conservation of genetic resources, Indonesia carried out a review of the 1993 Indonesian Biodiversity Action Plan. Results of the review were then formulated into the Indonesian Biodiversity Strategy and Action Plan 2003–2020, which has been published recently (BAPPENAS 2003).

Biosecurity regulations

Biosecurity is a sensitive issue for a major part of the Indonesian community, especially the question on genetically modified organisms (GMOs). However, there are probably only a limited number of scientists and people groups who really understand the issue.

Along with the development of genetic engineering technologies, the government is aware of the potential benefits and the potential dangers of this technology. In order to prevent the negative impacts of the use and production of GMOs, three related Ministries have put into effect a Joint Ministerial Decree on Biosecurity.

[1] PROPENAS = Program Pembangunan Nasional (National Development Programme)

Legislation relating to access, property rights, and benefit sharing

In the national context, the Forestry Act No. 41/1999 deals with the access to forest resources for different groups of communities. For example, under the Forestry Act, it is possible for individuals and cooperatives to be granted license to some forest-based business, such as environmental services and NTFPs. In addition, under this Act, a large-scale enterprise can be granted license to forest-based business involving a local cooperative.

Tenure and user rights for forestland and resources are also recognized. The Forestry Act (UU No. 41/1999) recognizes these rights. Furthermore, as a follow-up to the MOF Decree no. 31/Kpts-II/2000 regarding the implementation of community forest-based management, the Government has released 26 permits for local community-based forest management, covering an area of approximately 66 214 ha in 10 provinces.

Property rights and benefit sharing from genetic resources and products derived from them are also regulated under the Act No. 29/2000 regarding the Protection of New Varieties of Plants. In relation to the international arrangements, the formulation of Act No. 29/2000 also considered relevant aspects of international agreements such as the CBD, the International Convention for the Protection of New Varieties of Plants and the WTO/Trade Related Aspects of Intellectual Property Rights (Usman 2003). Moreover, Indonesia is currently in the process of formulating an act, which will regulate the utilization, management and conservation of genetic resources.

Capacity-building activities

Capacity building can be done both through formal education and 'learning by doing' exercises. Generally, training in FGR is included in tertiary education. A number of FGR-related courses, such as genetic conservation, biodiversity conservation and tree improvement are offered at both undergraduate and postgraduate levels. Most of these courses are managed by the Faculty of Forestry or, to a lesser extent by the Faculty of Agriculture (Department of Forestry). Some prominent universities with such courses are University of Gadjah Mada in Yogyakarta, Bogor Agricultural Institute in Bogor, and University of Mulawarman in East Kalimantan.

Strengthening the human resources is crucial for the government organizations. However, as domestic funding is limited, majority of capacity building activities have been carried out through bilateral cooperation in the form of (project-based) technical assistance programmes (with e.g. JICA, GTZ, DFID) and research grants from international agencies such as FAO, ITTO, Tropenbos International, CSIRO and ACIAR. Funding provisions for training and postgraduate studies overseas have normally been a part of the projects. Opportunities for learning by doing may be obtained both in research activities during postgraduate studies or through implementation of projects.

Public awareness efforts

Enhancing public awareness about issues related to natural resource management and environmental issues is one of the priority programmes of the government and is included in almost every development sector. Creating public awareness on FGR has been carried out by the MOF, MOE, NGOs and other related organizations. However, because of a number of factors, such as different priorities or focuses of the institutions and organizations, different funding sources and a lack of communication among the parties, unnecessary duplication of activities has often been unavoidable.

Proposals for regional and international collaboration

Regional cooperation

At this stage, the establishment of a network may encourage more intensive communication among the countries in the region. Some similarities among the countries, for example in forest tree species, ecosystems and sociocultural environment, can be used as entry points for developing the network. Extending the network to reach existing regional organizations, such as ASEAN, SEAMEO-BIOTROP and APC should also be considered in order to gain support from a broader scope of stakeholders in each of the member countries.

International cooperation

There are two important aspects that need to be addressed in international cooperation: first, international policies or agreements affecting FGR conservation and management at the national level and, second, business or commercialization of FGR along with the rapid development of biotechnology.

Various FGR conservation and management issues are covered under international agreements such as the CBD and the Cartagena Protocol, the International Treaty on Plant Genetic Resources for Food and Agriculture and other agreements in the WSSD process as well as the Trade-Related Aspects of Intellectual Property Rights (TRIPS). International cooperation through APFORGEN-APAFRI-IPGRI should be directed to address some crucial issues on FGR, such as access, benefit sharing, biosecurity and intellectual property rights. The cooperation should also include joint efforts in fighting against illegal trade of FGR. Research collaboration on FGR-related fields should also be promoted.

Recommendations for regional collaboration in FGR conservation and management

Some aspects that have been proposed to be addressed at the international level are also relevant to be brought into collaboration at the regional level. These include e.g. tackling issues related to access, benefit sharing, biosecurity and intellectual property rights. Joint efforts in fighting against illegal trade of FGR and research collaboration on FGR-related fields should also be promoted at the regional level.

Information sharing on FGR conservation, utilization and management as well as exchange of genetic material for research purposes are also potential fields for collaboration among countries in the same or similar regions.

Conclusions

In the context of Indonesia, the policy direction for the next twenty years will be towards the rehabilitation of degraded lands and forests and conservation of the remaining natural forests. It is anticipated that more advanced research on species domestication, tree improvement, genetic conservation and other related fields is needed. Research to tackle the ecological aspects of plantations (monocultures) is also important for sustainable genetic resource management. International and regional collaboration is needed to tackle various issues as mentioned in the previous chapters. Identification of priority species for each participating country should be continued by involving more institutions and other stakeholders in the countries.

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Appendix 1

Priority species for FGR conservation and management identified from various sources

Species	Product type		Source of data(*)
	Timber	Non-timber	
Acacia auriculiformis	✓		CFBTI
A. crassicarpa	✓	✓	CFBTI
A. mangium	✓		CFBTI
Agathis borneensis	✓		Perhutani
A. loranthifolia	✓		
Aleurites moluccanus	✓	✓	
Alstonia palembanica	✓		
A. scholaris	✓		CFBTI
Altingia excelsa	✓	✓	
Anthocephalus chinensis	✓		
Aquilaria malaccensis		✓	FORDA
Araucaria cunninghamii	✓		CFBTI
Arenga pinnata		✓	
Artocarpus altilis		✓	CFBTI
A. heterophyllus	✓	✓	
Azadirachta excelsa	✓	✓	
Calamus manan		✓	FORDA
Calophyllum inophyllum	✓		
Canarium asperum	✓	✓	
Cassia siamea	✓		
C. vera		✓	
Casuarina equisetifolia		✓	
C. junghuhniana	✓		
Ceiba pentandra		✓	
Cinnamomum sp.	✓	✓	FORDA
Dalbergia latifolia	✓		Perhutani
Diospyros celebica	✓		
Dipterocarpus spp.	✓		
Dryobalanops aromatica	✓	✓	
Duabanga moluccana	✓		
Durio zibethinus	✓	✓	
Dyera costulata	✓	✓	
Dysoxylum mollissimum	✓		
Elmerrillia ovalis	✓		
Eucalyptus deglupta	✓		
E. pellita	✓		CFBTI
E. urophylla	✓		
Eusideroxylon zwageri	✓		CFBTI
Fagraea fragrans	✓		
Gmelina moluccana	✓		
Gnetum gnemon		✓	
Gonystylus bancanus	✓		CITES Appendix III
Hopea mengarawan	✓		
Intsia bijuga	✓		
Koompassia malaccensis	✓		
Lophopetalum multinervium	✓		UGM, FORDA
Manilkara kauki	✓	✓	

Species	Product type		Source of data(*)
	Timber	Non-timber	
Melaleuca cajuputi var. *cajuputi*	✓	✓	CFBTI
M. leucadendra	✓		FORDA
Metroxylon sagu		✓	
Mimusops elengi		✓	
Myristica fragrans		✓	
Octomeles moluccana	✓		
Palaquium amboinense	✓		
P. rostratum	✓	✓	
Paraserianthes falcataria	✓	✓	CFBTI
Parkia speciosa		✓	
Pericopsis mooniana	✓		
Peronema canescens	✓		
Pinus merkusii	✓	✓	Perhutani, UGM
Pithecellobium jiringa		✓	
Pometia pinnata	✓	✓	
Pterocarpus indicus	✓	✓	
Rhizophora spp.	✓		
Samanea saman		✓	
Santalum album	✓	✓	CFBTI
Schima wallichii	✓	✓	
Schleichera oleosa	✓	✓	
Shorea javanica	✓	✓	
S. johorensis	✓		
S. laevis	✓		
S. leprosula	✓		UGM, FORDA
S. macrophylla		✓	
S. ovalis	✓		
S. parvifolia	✓		
S. pinanga		✓	CFBTI
S. polyandra	✓		
S. selanica	✓		
S. stenoptera	✓	✓	
Styrax benzoin		✓	
Swietenia mahagoni	✓		Perhutani, FORDA
Tarrietia spp.	✓		
Tectona grandis	✓		CFBTI, Perhutani
Toona sureni	✓		
Vitex pubescens	✓		

Note: (*) The primary source of data is Ministry of Forestry (MoF 1995)
Additional sources:
CFBTI = Centre for Forest Biotechnology and Tree Improvement
FORDA = Forestry Research and Development Agency
UGM = University of Gadjah Mada
Perum Perhutani (a state-owned forestry enterprise)