PRESENT STATUS OF CONSERVATION, UTILIZATION AND MANAGEMENT OF FOREST GENETIC RESOURCES IN INDONESIA

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Introduction

Indonesia has over 120 million hectares of natural forests. These represent a tenth of the world's remaining tropical rainforests and are among the most biologically diverse in the world. They are vital to Indonesia's economic development, meeting most of the domestic demand for wood and earning US$3.8–5.9 billion each year in wood product exports. These forests are also important for sustaining agriculture and soil and water resources. Owing to factors such as logging, conversion of forest land to other uses, fire and shifting cultivation, Indonesia's forests are being degraded and deforested at an unprecedented rate. This paper reports on the status of conservation, management and use of forest genetic resources in Indonesia.

Geography and forest resources

Indonesia comprises about 17,000 islands, fewer than half of which are inhabited. The country's total land area is 195 million hectares. Indonesia's climate is characterized by wet and dry seasons, with annual rainfall levels between 700mm and 4000mm. Kalimantan, Sumatra (excluding the northern coastal areas), Irian Jaya (excluding the southern regions), Sulawesi (excluding the central part), Maluku and Western Java have per-humid and semi-humid climates. Other regions have seasonal climates and the driest sites are in Nusa Tenggara.

The Indonesian archipelago is divided into two major biogeographic regions, the Oriental and the Australian. These are separated by the Wallace Line, which passes between Bali and Lombok islands and between Borneo and Sulawesi. Indonesia forms part of the Malesian botanical region. The Malesian rainforests are among the richest in the world in terms of their tree species diversity. One of their main features is the abundance of valuable dipterocarp trees, particularly in the western region of Indonesia (Sumatra and Kalimantan). Seasonal monsoon forests are found in Central and East Java, and savannah grasslands are common in Nusa Tenggara and southern Irian Jaya. Non-dipterocarp lowland forests and alpine vegetation are found in Irian Jaya. The main forest types can be categorized as follows:

- Coastal forests on beaches and sand dunes.
- Tidal forests including mangrove, nipah (*Nypa fruticans*) and other palm forests.

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- Heath forests on sandy soils of poor fertility.
- Peat forests on organic soils with peat layers of at least 50cm.
- Swamp forests, seasonally inundated by fresh water.
- Wetland forest, permanently inundated by fresh water.
- Evergreen forests, including moist primary lowland forests and riparian forests.
- Sub-montane forests, mainly between 1000m and 2000m.
- Montane forests, mainly above 2000m.
- Bamboo forests.
- Monsoon forest.
- Savannah forests in semi-arid areas.

Almost two-thirds of Indonesia's land area are covered by tropical forests. Of these, 33.5 million hectares are reserved for protection purposes, 20.5 million hectares for nature conservation, 35.2 million hectares for limited production, 23 million hectares for fixed production and 8 million hectares for conversion (Ministry of Forestry and Estate Crops 1999).

Plantation forests are found mainly on Java, and cover an area of about two million hectares. They consist of teak (*Tectona grandis*), Merkus pine (*Pinus merkusii*), mahogany (*Swietenia macrophylla*), rosewood (*Dalbergia latifolia*), agathis (*Agathis loranthifolia*), cajuput (*Melaleuca cajuputi*) and other species. Since the late 1980s, plantation forests have been established on islands other than Java, though mainly as short-rotation plantations for pulp and paper. By 2000, about 2.5 million hectares of plantations had been established on outer islands, particularly Sumatra and Kalimantan (Ministry of Forestry 2000).

Utilization of forest resources

Before 1970, activities in the forest sector concentrated on plantation forestry in Java using teak, pine and mahogany. These plantations are managed to produce timber for both domestic and foreign markets. The pine plantations in Java also produce oleoresin. Other products include cajuput oil and lacquer. Forest exploitation on other islands was not intensive and was done mostly by local communities. In the late 1980s, the government embarked on an ambitious programme to develop industrial tree plantations on islands other than Java.

In 1970, the government began to issue concession rights to state and private companies to exploit forest resources on the outer islands of Java. By 1990, more than 421 timber concessions were in operation, covering an area of almost 51.5 million hectares (Suryodibroto 2000). These concessions marked the start of large-scale exploitation of Indonesia's forests. Exports of mainly dipterocarp timber from these concessions contribute 54–85% of the total earnings from Indonesia's wood export sector (Apkindo 2000, cited by Kompas 2001). In addition to wood, these forests also provide non-wood products such as rattan, resins and illipe nuts.

Pressure on forests and forest genetic resources

A selective cutting system (later changed to a selective cutting and replanting system) is used in forest concession areas. This system adheres to principles of sustainability and is broadly similar to those developed by international initiatives in the 1990s. The system emphasizes sustainability in timber harvesting, biodiversity, soil and water conservation, forest ecosystems and forest management (Sukotjo 2000).

Under normal conditions, when only a few trees are harvested, logging is not a threat to natural forests because suppressed seedlings benefit from the increase in light levels caused by the opening of the canopy. Many concession holders, however, routinely violate regulations and damage the residual stand. High-quality and seed-bearing trees are often harvested first without consideration for the regeneration potential of the forest. As a result, the ability of logged-over forests to regenerate is diminished and secondary forest tree species often replace the dipterocarps. By closing the canopy, these secondary species make replanting and other silvicultural measures costly and ecologically uncertain (Kuusipalo 1996). The practice of felling the best specimens also reduces the size of the breeding population and can lead to genetic erosion through increased inbreeding (Boyle 1996). Many concession areas have been subject to illegal encroachment, although this has also occurred in protected forests.

The mismanagement of forests can be attributed mainly to an imbalance between the capacity of natural forests to provide a sustainable wood supply and the demands of the timber industry. The installed capacity of Indonesia's wood industry is about 58 million m^3 per year, whereas the yield potential of its natural forests is only about 25 million m^3 per year (Ministry of Forestry 2000). This excess capacity has contributed to massive forest degradation.

The second major reason for forest loss and degradation is the creation of tree plantations. The original aim of developing plantation forests on the outer islands was to convert unproductive alang-alang (*Imperata*) grasslands, scrublands and secondary forests into production forests. In reality, however, logged-over forests, which could have been maintained as natural forests, were clear-felled and planted with fast-growing tree species. To date, about four million hectares of forest land have been allocated to pulp and paper companies to establish pulp plantations.

Along with the increased demand for forest land for other uses, the Indonesian government has allocated some existing forest areas for conversion to agro-industrial plantations, mainly of oil palm (*Elaeis guineensis*). Between 1997 and 2000, about 420,000ha of oil palm plantations were established annually. The total area under oil palm cultivation is now 3.17 million hectares (Ministry of Forestry 2000).

Shifting cultivation has also contributed to deforestation. It is a particular problem where land is scarce and population pressure is high. Shifting cultivation has created an area of about 20 million hectares of alang-alang grassland in Indonesia (ITTO 1990). Recently, farmers have begun to plant tree crops such as rubber and kayu manis (*Cinnamomum* spp.) following the clearance of forest land (Sunderlin & Resosudarmo 1997).

Forest fire is also a great destroyer of forests in Indonesia. The large forest fires of 1983 and 1997 devastated hundreds of thousands of hectares of forest. The enormous forest fire in East Kalimantan in 1983 destroyed 3.6 million hectares of forest (ITFAP 1991). The fire of 1997 destroyed 2.3 million hectares of forest (Hoffman 1999).

The latest data indicate that over 40 million hectares of forest in Indonesia have been degraded or fragmented, and that the annual rate of deforestation has reached 1.46 million hectares. In Sulawesi alone the rate of deforestation is around 1% each year (Harsono 2000). Notwithstanding these damaging trends, the government is still expecting remaining forests to provide export earnings of US$8 billion by 2004 (Kompas 2001). This policy is believed to put even more pressure on Indonesia's already threatened forest genetic resources (Table 1).

Table 1. *Threatened species and degrees of conservation and security*

Species	Conserved in[a]			Threats and their causes[b]				Security[c]
	pa	mf	uf	ef	c&f	inf	oth	
Agathis borneensis			>10,000		mild			3
Alstonia scholaris			>10,000		mild			3
Aquilaria malaccensis			>10,000		mild			3
Dyera costulata			>10,000		serious			5
Diospyros celebica			>10,000					2
Eusideroxylon zwageri			>10,000		serious			3
Gonystylus bancanus	>10,000				serious			5
Lophopetalum multinervium			>10,000		serious			2
Manilkara kauki	>10,000				mild			2
Pericopsis mooniana					mild			3
Santalum album		>1,000			serious		poor policy	5
Shorea leprosula			>10,000		mild			2
Shorea laevis			>10,000		mild			2
Shorea palembanica					serious			4
Shorea stenoptera			>10,000		mild			3

a) pa = Protected area; mf = Managed forest; uf = Unmanaged forest.

b) ef = Environmental factors; c&f = Clearing & felling; inf = Development of infrastructure; oth = Others.

c) 1= High level of security; 2, 3, 4 = Value between 1 and 5; 5 = High risk of genetic loss.

Past and present activities in forest genetic resources

Demand and supply of seed for agroforestry and afforestation programmes

The Indonesian government launched a re-greening campaign to rehabilitate degraded forest lands in the late 1970s. Tree planting has been actively encouraged and in many parts of Indonesia the campaign has been quite successful. The campaign has created a strong demand for tree seed but farmers and technocrats are generally unaware of the need to use good-quality seed. The seed used in the programme has often had poor genetic and physiological qualities. Seed is commonly imported from other regions of the country that do not necessarily match the ecological characteristics of the planting sites. The government is aware of this problem and has been seeking remedial measures. One of these is the Indonesia Forest Seed Project, a collaborative project between Danida and the Ministry of Forestry.

At the start of plantation development in the late 1980s, inadequate local seed supplies, particularly for exotic species such as *Acacia mangium* and *Acacia crassicarpa*, meant that seeds had to be imported from Australia and Papua New Guinea. Today, good quality seed and other planting material for industrial tree plantations are becoming available locally as a result of tree improvement programmes. Table 2 lists some of the economically important tree species in Indonesia, their management and the location of their genetic resources.

Table 2. *Some economically important tree species in Indonesia, their management and the location of their genetic resources*

Species	Reserve National Park	Stands *in situ* *ex situ*	Protected natural stands	Protected planted stands	Villages fields homesteads	Experiment field trials
Acacia mangium						18 provenances 757 families
Acacia crassicarpa						9 provenances 261 families
Acacia auriculiformis						13 provenances 236 families
Alstonia scholaris					>10,000	
Diospyros celebica						158 families 11 provenances
Eucalyptus pellita						4 provenances 223 families
Gliricidia sepium						4 provenances
Gmelina arborea						4 provenances 80 families 72 clones
Manilkara kauki	>10,000	>1,000				
Melaleuca cajuputi						17 provenances 412 families
Lophopetalum multinervium		>10,000				5 provenances
Palaquium sp.				>10,000	>10,000	
Paraserianthes falcataria						10 provenances 300 families
Pinus merkusii		>10,000				3 provenances 1372 families
Santalum album					>1,000	421 families 8 provenances
Shorea javanica					>10,000	
Shorea johorensis						25 families
Shorea macrophylla						200 families 10 populations
Shorea pinanga						97 families
Shorea polyandra						25 families
Shorea leprosula		>10,000				
Swietenia macrophylla				>10,000		100 families
Swietenia mahagoni		>1,000				
Tectona grandis			> 1,000	>1,000	>10,000	600 families 200 clones

In situ conservation

The Indonesian government has made a policy commitment to protect 10% of the national territory in conservation areas. This commitment is clearly addressed in the Indonesian Tropical Forestry Action Programme. The government has designated 356 terrestrial conservation areas covering a total area of 17.7 million hectares (Table 3). These areas have been selected on the basis of their biological values and socio-economic benefits.

Table 3. *Conservation areas in Indonesia. Source: Forestry and Estate Crops Statistics of Indonesia (Ministry of Forestry 2000).*

Description	Units	Size (ha)
Nature reserve	167	2,464,767
Recreation park	79	293,681
Game reserve	47	3,550,085
National park	33	10,990,243
Grand forest park	15	247,876
Hunting park	15	247,392
Total	**356**	**17,794,046**

It is acknowledged that the existing conservation areas, though they play an essential role in conserving ecosystems and forest genetic resources, cannot satisfy fully the needs of gene conservation. The active conservation of intra-specific genetic diversity in many economically important species is limited to the point of non-existence. This state of affairs can be attributed partly to inadequate basic knowledge of the distribution of species, genetic variation and patterns of variation.

With the exception of conservation areas, well-planned and coordinated efforts for *in situ* conservation of forest genetic resources are still lacking. Nevertheless, attempts to conserve some species of economic importance have been made by various institutions. The Ministry of Forestry issued a decree for concession forests to set aside at least 300ha as an *in situ* conservation area, similar to the area specified in the ITTO guidelines for biodiversity conservation (ITTO 1993). This decree targets mainly dipterocarps. Whether it will be implemented, however, remains to be seen. In the province of Aceh, an attempt at *in situ* conservation of *P. merkusii* was made in 1993 by designating 20 natural stands as conservation stands. Each stand is at least 20ha in size, and contains more than 1000 individual trees (Hardiyanto 1994). *In situ* conservation of *Manilkara kauki* is also being carried out in West Bali National Park.

A number of conservation areas have been affected by encroachment and illegal logging, particularly since the economic and political crisis of 1997. Current management practices in protected areas are also ineffective. The majority of Indonesia's designated protected areas lack the prerequisites for good management, namely, secure boundaries, zoning of land use (including buffer zones) and basic information on resources. The boundaries of fewer than 10% of designated conservation areas have been physically demarcated (DGFPNC 1997).

Ex situ conservation

Indonesia has a number of long-established botanical gardens and arboreta, which conserve plant germplasm from forests. These are maintained by both public and private institutions, and include the Bogor Botanical Garden in West Java, Purwosari Botanical Garden in East Java and the Bali Botanical Garden. Gardens and arboreta play an important role in public education and raising awareness.

Ex situ conservation also forms part of tree improvement programmes. For example, Perum Perhutani, a state-owned enterprise, has established conservation stands of various teak varieties collected in Indonesia in 1998. *Ex situ* conservation has also been carried out for *P. merkusii* by collecting seeds from natural populations in Aceh and establishing breeding populations and conservation stands in Java (Hardiyanto & Danarto 2000). A programme of *ex situ* conservation of *Shorea leprosula* and *Lophopetalum multinervium* is also underway in

Java, Sumatra and Kalimantan. This is financed by ITTO and conducted by the Faculty of Forestry at Gadjah Mada University in cooperation with six state companies.

In contrast to wildlife conservation, progress in protecting threatened tree species has been slow. Comprehensive regulations for conserving individual plant species have yet to be developed. Table 4 describes the priority species that need conservation. Population data for these species are not available; the list is based on the common perception that these species are becoming increasingly difficult to find within their natural ranges.

Table 4. *List of priority species for conservation, improvement or seed procurement*

Species	Exploration & collection		Evaluation		Conservation		Use of germplasm	
	A[a)]	B	C	D	E	F	G	H
Alstonia scholaris	2[b)]	2	1	1	1	1	1	1
Aquilaria malaccensis	2	2	2	2	1	1	2	2
Dyera costulata	1	1	3	3	1	1	1	3
Diospyros celebica	2	2	2	2	2	2	1	2
Eusideroxylon zwageri	1	1	1	1	1	1	1	3
Gonystylus bancanus	1	1	1	1	1	1	1	3
Manilkara kauki	2	2	2	2	2	2	1	3
Palaquium sp.	3	3	2	2	2	2	2	2
Pericopsis mooniana	1	1	1	1	1	1	1	2
Santalum album	1	1	1	1	1	1	1	1
Shorea leprosula	1	1	1	1	1	1	1	1

a) A = Biological information; B = Collection of germplasm for evaluation; C = *in situ* (population studies); D = *ex situ* (provenance and progeny tests); E = *in situ*; F = *ex situ*; G = Semi-bulk/bulk seedlots; H = Selection and improvement, reproductive materials.

b) 1= Highest priority; 2 = Prompt action recommended; 3 = Action required in immediate future.

Tree improvement

Tree improvement work began in Indonesia in 1932 with provenance trials for teak at several sites in Java. A regular improvement programme, however, did not start until 1976, when progeny trials of *P. merkusii* were established. Since the beginning of the industrial tree plantation era in the late 1980s, various tree improvement programmes have been initiated for mainly short-rotation species. Table 5 below lists target species in current tree improvement programmes.

Institutional framework

At least three agencies within the Ministry of Forestry deal with forest genetic resources. The Directorate General for Forest Protection and Nature Conservation is the main body responsible for protecting and managing protected areas. The Directorate of Forest Tree Seed under the Directorate of Land Rehabilitation and Social Forestry is responsible for controlling, supervising and facilitating the use of good-quality seed for agroforestry and plantation programmes. The Centre for Forest Biotechnology and Tree Improvement under the Agency for Forestry Research and Development has adequate laboratory facilities and staff to conduct research and development in forest biotechnology and tree improvement. The Centre has a number of ongoing tree improvement projects for several species.

Table 5. *Species included in current tree improvement programmes in Indonesia*

Species	Provenance test	Progeny test	Clonal test	Seed stand	Seed orchard
Acacia mangium	✓	✓	✓	✓	✓
Acacia crassicarpa	✓	✓			✓
Acacia auriculiformis	✓	✓			✓
Acacia mangium x *Acacia auriculiformis*			✓		
Artocarpus heterophyllus		✓			
Eucalyptus deglupta	✓	✓			
Eucalyptus urophylla	✓	✓			
Eucalyptus brassiana		✓			
Eucalyptus grandis x *Eucalyptus urophylla*			✓		
Gmelina arborea		✓	✓		
Melaleuca cajuputi		✓			
Morus spp.			✓		✓
Paraserianthes falcataria	✓	✓		✓	✓
Pinus merkusii	✓	✓		✓	✓
Santalum album		✓			
Shorea johorensis		✓			
Shorea macrophylla		✓			
Shorea parvifolia		✓			
Shorea pinanga		✓			
Shorea stenoptera		✓			
Swietenia macrophylla		✓		✓	✓
Swietenia mahagoni				✓	✓
Tectona grandis	✓	✓	✓	✓	✓

Indonesia's Ministry of Environment has a direct mandate for environmental policy and regulation. It also plays an important role in developing strategies to conserve biological diversity and forest genetic resources specific to economic development. Other institutions responsible for managing biological resources include the Indonesian Science Institute (LIPI), the National Planning Board (BAPPENAS) and the Provincial Planning Agency (BAPPEDA).

Many non-governmental organizations also play an active role in the conservation of forest genetic resources. They are involved in development activities, stimulating public interest in forest policy issues and assisting the government in policy development and strengthening conservation efforts.

Universities such as Gadjah Mada University have also been involved in various tree improvement and conservation programmes. A number of forestry companies that manage industrial tree plantations have their own departments for research and development, and are active in tree breeding and conservation of important commercial species.

Indonesia's Basic Forestry Laws of 1967 and 1999 provide a basis for production and conservation objectives in forest management. They make specific reference to maintaining production forests, protecting the environment and conserving fauna and flora. The Act on Conservation of Living Resources and Their Ecosystems (1990), the Ministry of Forestry Decree on Germplasm Conservation in Production Forests (1990), and the Ministry of Forestry Decree on Criteria and Indicators for Sustained Production Forests (1993) provide further policy guidance for management and conservation.

The Indonesian government has also ratified a number of international conventions related to the management of forest resources, including the Ramsar Convention on Wetlands (1971) and the Convention on Biological Diversity (1992). It has also adopted the ITTO Guidelines for Sustainable Forest Management (1993).

Current policy and legislation for forest genetic resources are considered comprehensive and perceptive. They recognize the value of renewable forest genetic resources and the need for sustainable use and management. Monitoring and enforcement, however, remain weak. Inconsistencies in policy application, a lack of resources and weak control over implementation are among the reasons for the failure of regulation. Since 2001, the central government has been decentralizing responsibility for implementing policy, including forest policy, to local and provincial governments. The implications of decentralization for the management, conservation and utilization of forest genetic resources are still unclear. However, local governments may increase the pressure on Indonesia's remaining forests if they try to extract higher revenues from forests placed under their jurisdiction.

Identification of national priorities

A national workshop was held in 1995 to identify priority species for reforestation, re-greening (agroforestry), industrial plantations and soil water conservation (Departemen Kehutanan 1995). A more recent workshop in 2000 on regional planning for forest seed source development, facilitated by the Indonesia Forest Seed Project, also identified priority species for the seed programme. Table 6 summarizes the priority species identified by these two workshops.

Table 6. *Value and use of target, important species in Indonesia. Source: Departemen Kehutanan (1995); Workshop on Regional Planning for Seed Source Development.*

Species	Value Code[a)]	Present, future or potential use[b)]											
		ti	po	wo	nw	pu	fo	fd	sh	ag	co	am	xx
Acacia auriculiformis	1	✓								✓			
Acacia crassicarpa	1					✓							
Acacia mangium	1					✓							
Agathis borneensis	1	✓											
Agathis loranthifolia	1	✓											
Aleurites moluccana	1	✓			✓								
Alstonia palembanica	1	✓											
Alstonia scholaris	1	✓											
Altingia excelsa	1	✓									✓		
Anthocephalus chinensis	1	✓											
Aquilaria malaccensis	1				✓								
Arenga pinnata	1						✓						
Artocarpus altilis	1						✓						
Artocarpus heterophyllus	1	✓			✓		✓						
Azadirachta excelsa	1	✓								✓			
Calamus manan	1				✓								
Calophyllum inophyllum	1	✓											
Canarium asperum	1	✓					✓						
Cassia siamea	1			✓							✓		
Cassia vera	1				✓								
Casuarina equisetifolia	1										✓		
Casuarina junghuhniana	1			✓									
Ceiba pentandra	1				✓					✓			
Cinnamomum sp.	1	✓			✓								
Dalbergia latifolia	1	✓											

Table 6. *(continued)*

Species	Value Code[a)]	Present, future or potential use[b)]											
		ti	po	wo	nw	pu	fo	fd	sh	ag	co	am	xx
Diospyros celebica	1	✓											
Dipterocarpus spp.	1	✓											
Dryobalanops aromatica	1	✓			✓								
Duabanga moluccana	1	✓											
Durio zibethinus	1	✓					✓						
Dyera costulata	1	✓			✓								
Dysoxylum mollissimum	1	✓											
Elmerrillia ovalis	1	✓											
Eucalyptus deglupta	1	✓											
Eucalyptus urophylla	1	✓											
Eusideroxylon zwageri	1	✓											
Fagraea fragrans	1	✓											
Gmelina moluccana	1	✓											
Gnetum gnemon	1						✓			✓			
Gonystylus bancanus	1	✓											
Hopea mengarawan	1	✓											
Instia bijuga	1	✓											
Koompassia malaccensis	1	✓											
Lophopetalum multinervium	1	✓											
Manilkara kauki	1	✓										✓	
Melaleuca cajuputi	1		✓	✓									
Melaleuca leucadendron	1		✓										
Metroxylon sagu	1						✓						
Mimusops elengi	1											✓	
Myristica fragrans	1						✓						
Octomeles moluccana	1	✓											
Palaquium amboinense	1	✓											
Palaquium rostratum	1	✓			✓								
Paraserianthes falcataria	1	✓								✓			
Parkia speciosa	1					✓				✓			
Pericopsis mooniana	1	✓											
Peronema canescens	1	✓											
Pinus merkusii	1	✓			✓								
Pithecellobium jiringa	1						✓						
Pometia pinnata	1	✓					✓						
Pterocarpus indicus	1	✓										✓	
Rhizophora spp.	1			✓							✓		
Samanea saman	1								✓			✓	
Santalum album	1	✓			✓								
Schima wallichii	1	✓			✓								
Schleichera oleosa	1			✓	✓								
Shorea javanica	1	✓			✓					✓			
Shorea johorensis	1	✓											
Shorea laevis	1	✓											
Shorea leprosula	1	✓											
Shorea macrophylla	1				✓								
Shorea ovalis	1	✓											
Shorea parvifolia	1	✓											
Shorea pinanga	1				✓								
Shorea polyandra	1	✓											
Shorea selanica	1	✓											
Shorea stenoptera	1	✓			✓								
Styrax benzoin	1				✓								
Tarrietia spp.	1	✓											
Tectona grandis	1	✓											
Toona sureni	1	✓											
Vitex pubescens	1	✓		✓									

[a] 1= Species of current socio-economic importance; 2 = Species with clear potential or future value; 3 = Species of unknown value given present knowledge and technology.

[b] ti = timber production; po = post, pole, roundwood; pu = pulp and paper; wo = fuelwood, charcoal; nw = non-wood products; fo = food; fd = fodder; sh = shade, shelter; ag = agroforestry system; co = soil and water conservation; am = amenity, aesthetic, ethical value; xx = other.

Other activities

As a developing country, Indonesia has great difficulty in allocating adequate funds for training and education in forestry and conservation-related activities. Eight state universities offer forestry training courses. Half of these have independent forestry faculties and half offer a forestry curriculum within their agricultural faculty. Only two forestry faculties offer specialized training in conservation and tree breeding. An additional four private universities offer forestry degree programmes. In general, there are adequate facilities in Indonesia for degree courses in forestry. However, there are still insufficient resources and staff for research or post-graduate teaching in forest genetic resources.

At the technical level, there are four Forestry Senior High Schools and eight Forestry Training Centres in the country. The current number of technicians in forest genetics is inadequate. The growing pressures on Indonesia's remaining forests call for more technicians with better knowledge of the conservation and management of forest genetic resources to enhance field implementation.

The Indonesian government has recognized the traditional role of communities in forest management. In reality, however, local communities living in or near forests have not been given clear roles or responsibilities for managing forest genetic resources. The future sustainability of these resources depends on clarifying the roles and responsibilities of various forest stakeholders, including local communities, and promoting collaboration between different groups.

Regional and international collaboration

Indonesia has cooperated with various regional and international organizations dealing with forest or forest genetic resources, including FAO, UNESCO (through its Man and the Biosphere programme), UNEP, IUCN, WWF, ITTO, ASEAN, SEAMEO, JICA, USAID, GTZ, the Rockefeller Foundation and the Ford Foundation. This cooperation must be maintained if the challenge of protecting Indonesia's forest genetic resources is to be met. Regional collaboration among the countries of ASEAN also needs to be strengthened, particularly in the fields of research, development and conservation of common regional species. The joint management of a protected area on the border between Indonesia and Malaysia in West Kalimantan and Sarawak is a good example of such regional collaboration.

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