CONSERVATION, UTILIZATION AND MANAGEMENT OF FOREST GENETIC RESOURCES IN THE PHILIPPINES

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Introduction

It is well known and recorded that the forests of Southeast Asia, including those of the Philippines, are the most biodiverse terrestrial ecosystems on Earth. These forests, however, face serious threats from social and economic development. The factors that contribute to forest loss and degradation include shifting cultivation, cash cropping, firewood collection, livestock grazing, unsustainable logging and anthropogenic fires intensified by exceptional droughts. The underlying causes of forest problems are poverty, over-population, inequitable land tenure regimes, misguided policies, weak governments and debt burdens.

The Philippine government is aware of the uniqueness and exceptional diversity of the country's forests. Appreciation is also growing of the role of forest genetic resources in sustaining the productive and protective values of forests, and the need to conserve these resources. Strong economic reasons lie behind this appreciation. A large number of tree species in the Philippines are harvested for their timber and, to a lesser extent, non-wood products such as bark, resin, tannin and medicinal compounds. Forest product exports make an important contribution to the Philippine economy. In future, ecotourism and genetic resources are likely to play a much greater economic role. The number of tree species being exploited is not known, but given their value and the threats they face, conservation efforts must be strengthened considerably.

Status of forests and forest genetic resources

In terms of its social and economic impacts, forest management in the Philippines has passed through two stages and is entering a third. In stage one, large areas of forest were converted to farmland to support a growing population. In stage two, the country sought to augment agricultural development by developing an industrial economy based largely on natural resources. Forest exploitation accelerated during this stage, resulting in a logging boom. Faced with diminishing forest resources, local forest-based industries were forced to diversify or go out of business. In the third, and current, stage, concerted efforts are being made to reverse the decline in forest area and quality, and protect the country's remaining natural forests.

The contribution of forestry to the Philippine economy has been eroded by massive deforestation during the past two decades. Pressure from a growing population, demands for agricultural land, urbanization and logging are among the reasons behind forest loss. Poor planning and execution of forest management programmes, weak enforcement of forest laws, political pressures, inadequate policies for forest protection and development, and the low priority historically given to forest conservation and environmental protection have exacerbated deforestation and frustrated attempts to solve forest problems.

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The Philippines once had an abundant cover of forests. As late as 1989, 15 million hectares or half of the country's land area was still classified as forest. According to the latest forest inventory (1998), the area of forest has now declined to about 6.7 million hectares (Table 1).

Table 1. *Land use and forest types in the Philippines, 1998. Source: 1998 Philippine Forest Statistics.*

Land Use	Area ('000 ha)	Percentage of total area
Forest		
Dipterocarp old-growth	984.1	3.3
Dipterocarp residual	3,455.8	11.5
Pines	238.3	0.8
Mossy/Marginal	1,412.7	4.7
Mangroves	119.1	0.4
Plantations	466	1.5
Extensive		
Brushlands	2,459.1	8.2
Large-scale plantations	1,559.6	5.2
Other extensive	4,832.5	16.1
Cropland	13,544	45.2
Waterways, built-up areas, etc.	928.8	3.1
Total	**30,000**	**100**

The optimal area of forest for the Philippines is believed to be about 12 million hectares, or 40% of the land area. Given that only 6.7 million hectares are currently forested, this means that an additional 5.3 million hectares of land must be reforested. To achieve this goal, the government is implementing a Master Plan for Forestry Development that aims to reverse deforestation, conserve all virgin (old-growth) forests and manage residual forests and plantations efficiently and sustainably.

The Philippine government aims to meet its reforestation targets by cooperating with various sectors of society. Private sector plantations will focus on timber production. Government plantations will rehabilitate degraded forest areas and protect watersheds. The National Forestation Programme (NFP) aims to reforest 100,000ha each year.

A shortage in wood supply is expected if not enough plantations are established, even under Master Plan conditions (Table 2). Even if a total logging ban is effective, the projected raw material demand of wood-based industries in 2015 can only be met through plantations. Additional reasons for urgently establishing forest plantations in the Philippines are:

- The need for wood and forest products in the future;
- The need to protect watersheds and other vital interests;
- To provide urgently needed employment in rural and urban areas; and
- The need to distribute the benefits of natural resource exploitation more equitably.

Table 2. *Projected log supply and demand (in millions of cubic metres). Source: 1990 Master Plan for Forestry.*

	With new plantations			Without new plantations		
	1990	**2000**	**2015**	**1990**	**2000**	**2015**
A. Total Logging Ban Scenario						
1. Sawlog supply						
Dipterocarps	1.60	0.00	0.00	1.60	0.00	0.00
Pine	0.20	0.00	0.00	0.20	0.00	0.00
Old plantation	0.38	0.77	1.09	0.38	0.77	0.00
New plantation	0.00	1.22	6.00	0.00	0.00	0.00
Sub-total	2.18	1.99	7.09	2.18	0.77	0.00
2. Sawlog demand	1.77	2.89	5.35	1.77	2.89	5.35
3. Balance	0.41	*-0.90*	1.74	0.41	*-2.12*	*-4.26*
B. Master Plan Scenario						
1. Sawlog supply						
Dipterocarps	1.60	2.15	2.25	1.60	2.15	2.55
Pine	0.20	0.20	0.20	0.20	0.20	0.20
Old plantation	0.38	0.77	1.09	0.38	0.77	1.09
New plantation	0.00	1.62	9.59	0.00	0.00	0.00
Sub-total	2.18	4.74	13.43	2.18	3.12	3.84
2. Sawlog demand	1.77	2.89	5.36	1.77	2.89	4.26
3. Balance	0.41	1.85	8.07	0.41	0.23	*-0.42*

Enough land exists in the Philippines to establish plantations to supply future demand (Table 3). Potential plantation areas, which are scattered across the Philippine archipelago, are defined as open, denuded or inadequately stocked lands on slopes not exceeding 50%, for which there are no other uses. Considerable potential also exists to establish plantations on alienable and disposable lands that are currently lying idle, in areas with slopes less than 30%.

Table 3. *Suitable areas for establishing production plantations, by slope. Included areas are 80% of all grassland and brushland; 30% of all land under extensive land use; and 10% of residual forests (inadequately stocked logged-over areas). Source: DENR/MPFD land-use database.*

	Area ('000 ha)	
	<30%	**<50%**
Forest land	1,609	2,864
Alienable and disposable land	1,354	1,626
Total	**2,963**	**4,490**

There is now also strong political will to involve upland dwellers and non-governmental organizations in establishing and managing tree plantations. Some of the important programmes in this regard are:

- Tree planting contracts with forest dwellers on land under stewardship contracts, as a part of the community-based forest management project;
- Industrial Forest Management Agreements (IFMA);
- Reforestation as a part of the Timber License Agreements (TLA) issued to private individuals or corporations involved in forest utilization; and
- Forest Land Management Agreements (FLMA), which give households and community contractors the right to harvest what they have planted.

National programmes for conservation and management of forest genetic resources

Tree improvement and genetic resource conservation activities in the Philippines take place under national reforestation programmes, but are not clearly defined. Breeding of forest trees has historically been underemphasized, owing to a preference for natural regeneration methods such as seed trees for pines and selective logging for dipterocarps. Changes in environmental and socio-economic conditions, however, have promoted more intensive plantation approaches that require specific tree improvement and genetic resource conservation efforts.

In situ conservation

As early as 1930, legislation was passed to prevent logging of four leguminous timber tree species; namely, supa (*Sindora supa*), akle (*Albizia acle*), tindalo (*Afzelia rhomboidea*) and ipil (*Intsia bijuga*), as well as a non-legume, *Vitex parviflora*. Harvesting of an indigenous legume, narra (*Pterocarpus indicus*), and of any dipterocarp species from virgin forest for log export, have also been regulated.

The plant genetic resources of a country are assets that should be protected by clear national policies on their conservation and use. The sustainable use of each production forest or management unit in the Philippines varies according to size, shape, species composition, concentration of endemic species and so on. The conservation value of any given area is reflected in its management objectives and the quality of management. Because the conservation of forest genetic resources is fundamental to the sustainable and productive management of forest ecosystems, *in situ* conservation efforts should be reinforced.

Integrated protected area systems

The main strategy for protecting and conserving biodiversity in the Philippines is the establishment of an integrated protected area system (IPAS). The IPAS was set up to protect and preserve a representative sample of all ecosystems and habitat types in the country, as well as their plant and animal species. Executive Order 192 created the Parks and Wildlife Bureau to consolidate government efforts to conserve biological diversity in the protected area system.

In June 1992, Republic Act No. 7586, otherwise known as the National Integrated Protected Area Systems (NIPAS) Law, was passed. The law, which is being implemented by the Department of Environment and Natural Resources (DENR), has the following special features:

- It requires the designation of a buffer zone to stabilize protected areas whenever and wherever applicable;
- It recognizes ancestral rights and includes community interests with concern for socio-economic development;
- It requires the development of standard planning for site-specific management;
- It establishes the Integrated Protected Areas Fund (IPAF), a trust fund which will form the basis of a sustained financing system; and
- It adopts a decentralized system of protected area management.

By 1999, 76 protected areas had been established under the NIPAS Law. The regional offices of DENR, its Community Environment and Natural Resources Offices, and provincial

Environment and Natural Resources Offices have also identified 25 old-growth and mossy forests for inclusion in the IPAS.

Plus tree selection

Plus trees are being selected continuously across the Philippine archipelago. The criteria for selection are based on morphology and resistance to pests and diseases, but there have been few attempts to propagate the selected trees in nurseries. In 1991, plus trees from 23 species in eight administrative regions of the country were selected. Thirty-eight seed production areas (SPA) have been identified and documented. The Forest Management Bureau (FMB) has also identified 61 seed production areas for 19 tree species. Plans to improve the genetic composition of these SPAs are under development. Although seed is being collected from selected plus trees and SPAs, a system to monitor the transfer of germplasm and its performance after planting is not yet in place.

Ex situ conservation

There have been several *ex situ* conservation projects and programmes in the Philippines. Seed orchards of various species have been established in several parts of the country under both private and government initiatives. In most cases, however, these orchards have been abandoned because of a lack of funds or trained personnel. Financial and technical needs for rehabilitating these orchards are being studied.

A resurgence of efforts to establish more seed orchards has followed implementation of the National Forestation Programme. Nine seed orchards for 12 species were established in 1991 alone. For example, a 1.25ha seed orchard of *Eucalyptus deglupta* was established in 1991, with 500 grafted trees planted at a spacing of 5m x 5m.

Species and provenance trials have also been used for *ex situ* conservation purposes in the Philippines. Some provenance and species trials have been conducted by DENR for *Pinus*, *Acacia*, *Eucalyptus*, *Casuarina*, *Gmelina* and other multipurpose tree genera. PICOP Resources Inc. (formerly the Paper Industries Corporation of the Philippines) and Provident Tree Farms Inc. have conducted provenance trials of industrial plantation species such as moluccan sau (*Paraserianthes falcataria*), *Gmelina arborea* and *Endospermum peltatum*. The Ecosystems Research and Development Bureau (ERDB) has also recently begun provenance trials for several *Gmelina*, *Acacia* and *Eucalyptus* species in Cavite province. In Luzon and Mindanao, superior species have been identified and provenance trials established through joint efforts by DENR and the New Zealand government, for example the ASEAN-New Zealand Afforestation Project and Bukidnon Forest Industries.

Introduced species such as mahogany (*Swietenia macrophylla*) and *P. falcataria* are now considered naturalized exotics. *P. falcataria* plantations have been established from a single seed source and have a narrow genetic base. Except for the work of PICOP Resources, no efforts have been made to broaden the genetic base of *Paraserianthes* or *Swietenia*. The outbreak of gall rust disease in Mindanao that devastated the Bukidnon plantations and infected other plantations in Luzon can be attributed to the narrow genetic base of these plantations.

Clonal propagation plays an important role in the preservation of genotypes. Several methods have been used including macropropagation (e.g. air layering, grafting, rooting of cuttings) and tissue culture. Macropropagation is commonly used for species with recalcitrant seeds, such as dipterocarps. Siarot (1991) and Umali-Garcia and Melegrito (1995) established a

macropropagation protocol for inter-specific hybrids of *Acacia* and *Eucalyptus*. Umali-Garcia (1990a) established the protocols for rooting of *Gmelina* shoot tips and nodal cuttings. Oporto and Umali-Garcia (1998) successfully propagated several endangered species, including *Diospyros philippinensis*, *Dracontomelum dao*, *Tectona philippinensis* and *Agathis dammara*.

The protocols for rooting of stem cuttings have been established in a number of species, for example Dipterocarpaceae (Pollisco 1995; De la Cruz 1995; Oporto & Umali-Garcia 1998), *P. falcataria* (Budelman 1989), *Eucalyptus* hybrid (Siarot 1991), *S. macrophylla*, *V. parviflora* (Umali-Garcia 1995), *Pittosporum pentandrum* (Umali-Garcia 1998), *Pinus merkusii* (Umali-Garcia 1996) and *A. dammara* and *T. philippinensis* (Oporto 1999).

Successful tissue culture protocols have been developed for *P. indicus* (Calinawan & Halos 1984), *Acacia mangium* (Lapitan 1990), *P. falcataria* (Umali-Garcia 1990b), *E. peltatum* (Quimado & Umali-Garcia 1997), *Eucalyptus* sp. (Halos 1985), *Pinus caribaea* (Halos 1992) and *Cratoxylon sumatranum* (Quimado 1991). A variety of commercially important indigenous and endemic species, as well as those reported to be rare, threatened or endangered, require special attention for *ex situ* and *in situ* conservation. A forest biotechnology programme at the College of Forestry and Natural Resources of the University of the Philippines, Los Baños (UPLB) focuses on tissue culture of selected industrial plantation species.

Nine botanical gardens exist in the Philippines with 16,000 taxa under cultivation (Fernando 1998). The first to be established was Makiling Botanic Gardens (MBG) in 1968. MBG maintains both *ex situ* and *in situ* conservation stands of various timber species, for example *S. macrophylla*, *P. falcataria*, *V. parviflora* and several species of dipterocarps. A problem with these stands, however, is the lack of documentation on the origin of the introduced species.

Seed banks, clone banks, plant museums and *in vitro* banks are other *ex situ* approaches, but none has been used for timber species in the Philippines. The Institute of Plant Breeding at UPLB maintains a genebank for agroforestry species such as *Gliricidia sepium*, and a collection of fruit and endemic tree species. The Institute also has a genebank that can store seeds and tissues for an indefinite period of time. It is currently storing specimens of cereals and horticultural and ornamental species, but not timber species. Nevertheless, the Institute is planning to start a programme of conservation of indigenous palms and selected forest species. The ERDB has also established a genebank for rattan and bamboo in Mt. Makiling Forest Reserve.

Institutional framework for conservation of forest genetic resources

Government programmes of tree breeding and propagation are spearheaded by DENR with support from the Forest Management Bureau and ERDB. DENR has prime responsibility for promoting the well-being of the Filipino people through sustainable development of the country's forest resources, optimal use of forest lands, social equity and effective forest management. Various state universities and colleges also support DENR through research and training (both academic and practical) of government personnel. In this regard, the main contributor is UPLB, specifically its College of Forestry and Natural Resources, Institute of Plant Breeding and Institute of Biotechnology Research. Other contributing state universities include the Don Mariano Marcos State University, the Central Luzon State University, the Central Mindanao University and the Visayas State College of Agriculture.

The Philippines has promulgated several laws and policies dealing with conservation, protection and sustainable use of natural resources. Several laws directly or indirectly related to protecting and conserving forest genetic resources are detailed below.

The Philippine constitution has the following provisions relating to the conservation of tree species:

- Support and protection by the State for the right of all Filipino people to a balanced and healthy ecology in accordance with the rhythm and harmony of nature (Sec. 16, Art. II); framework of national unity and development (Sec. 22, Art. II).
- State ownership of all natural resources, except for agricultural lands (Sec. 2, Art. XII).
- Full control and supervision by the State of exploration, development and use of natural resources either by directly undertaking such activities or by entering into co-production, joint ventures or production-sharing agreements with Filipino citizens or Filipino-owned or controlled corporations or associations (Sec. 2, Art. XII).
- Small-scale utilization of natural resources (Sec. 2, Art. XIII).
- Determination by Congress of the specific limits of forest lands by marking their boundaries on the ground (Sec. 4, Art. XIII).
- State protection of the rights of indigenous cultural communities to their ancestral lands to ensure their economic, social and cultural well-being (Sec. 5, Art. XII).

The Philippines is committed to protecting and conserving its biological resources through the Philippine Strategy for Sustainable Development (PSSD). This was endorsed by former President Corazon Aquino and subsequently approved by the Cabinet in 1989 as a response to the global call for well-balanced resource development. One of the ten major strategies of the PSSD is biodiversity conservation. A sub-committee on biodiversity has been created by the Philippine Council for Sustainable Development and is chaired by DENR's Protected Areas and Wildlife Bureau. In 1994, the sub-committee formulated the Philippine Strategy for the Conservation of Biological Diversity (PSBD), which subsequently provided a basis for a 1995 biodiversity study supported by UNEP. This study transformed the PSBD into a National Biodiversity Strategy and Action Plan for the Philippines (NBSAP), which was approved in June 1997. The signing of the Convention on Biological Diversity (CBD) by the Philippines in 1992 increased appreciation and interest in biodiversity conservation.

The NBSAP has the following goals and objectives:

- Conservation of diversity through improved knowledge, management systems, research and development, information and institutional support;
- Sustainable use of biodiversity;
- Equitable sharing of the benefits derived from biodiversity;
- Collaborative approaches to conservation strategies and management activities;
- Formulation of policies for the conservation, sustainable use, and equitable sharing of biodiversity benefits;
- Integration of biodiversity conservation strategies into development planning;
- Practice of conservation ethics for using biodiversity;
- Multi-sectoral participation in biodiversity conservation; and
- Fulfilment of the country's obligations to various international agreements on biodiversity conservation.

The following strategies and actions have been proposed to implement the above-mentioned objectives:

- Expanding and improving knowledge of the extent, characteristics, uses and economic values of biodiversity;
- Enhancing existing and planned biodiversity conservation efforts, and identifying potential actions, consolidating research and development, and setting up a network of conservation centres;
- Formulating policies and laws on biodiversity conservation that emphasize sustainable use and equitable sharing of benefits;
- Integrating biodiversity conservation into all levels of government and non-government planning, and strengthening human resources capability for biodiversity conservation;
- Mobilizing and integrating information, education and communication on biodiversity systems; and
- Advocating stronger international cooperation in biodiversity conservation.

Apart from the NIPAS Law (see above), eight other decrees, orders or proclamations curb activities that may adversely impact biological diversity. Of these, the following relate to conserving forest genetic resources:

- **Presidential Decree No. 1151**. The Philippine Environment Policy of 1978 established the Philippine Environmental Impact Assessment (EIA) System. This law stipulates environmental impact assessments for all activities or projects that may significantly affect the quality of the environment.

- **Proclamation No. 2146**. This identifies protected areas as environmentally critical and therefore within the purview of the EIA system provided for under Presidential Decree 1586. It is supported and strengthened by DENR Administrative Order (DAO) No. 21, which decentralizes the issuing of environmental compliance certificates for projects within environmentally critical areas.

- **DAO No. 90 series of 1988**. This sets quotas for certain animal and plant species collected under a permit for commercial purposes.

- **DENR Memorandum Order No. 97-17**. This protects the habitats of endemic, rare, vulnerable and endangered wetland species.

- **CITES**. The Philippines joined the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1981.

- **Executive Order No. 247**. This was issued in 1995. It emphasizes “prescribing guidelines and establishing a regulatory framework for prospecting biological and genetic resources, their by-products and derivatives for scientific, commercial and other purposes”. The rules and regulations of implementation are in DAO No. 96-2.

- **DAO No. 95-9**. This pronounced that “the basic policy of the government is to establish well-adapted populations of forest trees which provide a sustained supply of forest tree seed and other planting stock for the country’s reforestation programme”.

The production, procurement, collection, distribution and use of planting materials were placed under monitoring and regulation by DENR.

National priorities in conservation

These are as follows:

- Coordination of all government agencies and non-governmental organizations involved in tree breeding and propagation. The mandate of DENR will include the proper management of the country's forest genetic resources. This will be supported by formulating and enforcing policies on seed certification and monitoring.

- Strengthening of government units directly involved in forest management, in line with sustained implementation of long-term tree improvement research and development programmes. A substantial number of nurseries are being planned in the provinces. These are designed to increase the supply of planting stock to meet provincial and national requirements.

- A campaign to promote investment in the seed production industry by non-governmental organizations, particularly to reinforce programmes for producing genetically improved seed.

- Increasing the production of genetically superior seed and planting stock by establishing and maintaining additional improved seed-production areas (i.e. seed and clonal orchards), and species and provenance trials of indigenous and exotic sources. This includes that assessment and rehabilitation, if necessary, of all previously established species, provenance and progeny trials, and seed orchards.

- Continued research and development of superior forest plantations. Possible areas for research include site-specific adaptability testing, increasing seed production by orchards, development of propagation techniques, pollination, hybridization and recurrent selection techniques.

- Conservation of important germplasm produced by current research activities in selection and hybridization.

Education and training activities

Biotechnology is one of the banner programmes of the Philippines Science and Technology Agenda for National Development (STAND 2000). This forms part of a national effort to address problems in industry, environment, agriculture, food, health, and security. The country has identified capacity building, infrastructure development, public education and research and development activities as core areas of attention.

Successful conservation of plant genetic resources depends largely on institutional capacities to implement suitable programmes and projects. Some of the activities of different organizations concerning education and training in biodiversity conservation are detailed below.

Some schools, colleges and universities in the Philippines offer courses in biodiversity conservation or genetic conservation, but none offers courses specifically in genetic conservation of tree species. Sixty-six schools offer traditional undergraduate degrees in

biology. These include basic courses in taxonomy, genetics, pharmacology, microbiology, agronomy, entomology, crop sciences, plant breeding and other subjects.

The UPLB Graduate School currently offers master's and doctoral programmes in molecular biology and biotechnology. It has also introduced a graduate course in plant genetic resources conservation. UPLB's College of Forestry and Natural Resources also offers courses in forest genetics and advanced tree improvement. The College has prepared a course proposal for post-graduate degrees in forest resources management. Other courses include environmental planning and environmental education for agriculture and forestry. Several schools and colleges, such as the College of Arts and Sciences at the University of the Philippines Diliman, the College of Biological Sciences at Visayas State College of Agriculture, the Mindanao State University and Miriam College, also offer formal courses in biodiversity.

Informal courses in biodiversity conservation, environmental protection and planning are offered in various parts of the country by several public, private and international institutions. The Institute of Molecular Biology and Biotechnology and the International Rice Research Institute offer training courses in molecular genetics for biodiversity conservation. The Protected Areas and Wildlife Bureau conducts training courses and workshops in CITES-related programmes and projects. Several private and non-governmental organizations also offer training in community organization, biodiversity conservation, NIPAS and buffer zone management. A recent workshop on market-based instruments was conducted in collaboration with UPLB's Makiling Centre for Mountain Ecosystems.

The Regional Centre for Graduate Study and Research in Agriculture (SEARCA) of SEAMEO has organized several training workshops on biodiversity. The newly established ASEAN Regional Centre for Biodiversity Conservation is mandated to promote, enhance capacity and coordinate all initiatives in biodiversity conservation in ASEAN member states. The Philippine Rural Reconstruction Movement also conducts training in biodiversity conservation.

UPLB's College of Forestry and Natural Resources, through its training arm TREES (Training Centre for Tropical Resources and Ecosystems Sustainability), offers short-term informal courses to forestry graduates and professionals on continuing professional education through a training module on 'Recent Advances in Forest Technologies'. DENR also offers training sessions to its staff and other individuals in biodiversity conservation, environmental impact assessment, watershed management and community-based forest management.

Possible cooperative activities

DENR must continuously upgrade its capabilities in tree improvement if it is to support effectively the national reforestation programme. DENR also intends to accelerate the establishment of more trial plantations nationwide. These should be able to secure good collections of seed from potential sources outside the country. The DENR/ERDB network can be used to conduct seed collection within the country. Trained seed collectors are available. However, DENR can provide only limited funds for this activity and may need assistance to accommodate requests for collection from other countries. The Philippines will also continue to participate in international species and provenance trials which support the national reforestation programme.

Other issues related to conservation

Political issues

Experience in the Philippines has shown how national priorities change with frequent changes in political leadership. This affects reforestation as much as other environmental programmes. Strong and continued political commitment at all levels is vital to the successful establishment and management of forest plantation programmes.

A review and, if necessary, reformulation of existing national land-use classification policies is underway to develop guidelines for sustainable land use. These policies should be an integral part of national socio-economic strategies and plans for the development of industry and employment. Policies and laws to encourage long-term investments in forests and forest-based industries are also needed. Important issues are the security of land-tenure arrangements, and local acceptance of suggested land allocations (e.g. for forest plantations).

Political solutions are also needed to streamline the management of forest genetic resources. Although it is accepted that the government should control and regulate the production, sale and movement of genetic materials within and into the country, appropriate policies or laws have yet to be formulated. These should incorporate appropriate schemes to regulate and certify the quality and price of planting stock (e.g. seeds, seedlings or clones), and to monitor its movement or transfer.

Bio-ecological issues

Attempts to re-establish forests on abandoned agricultural lands or fire-ravaged areas have encountered difficulties with poor seedling growth and survival, and outbreaks of pests and diseases. Poor soil and microclimatic conditions have also created problems. Varying site conditions and reforestation objectives (i.e. for production and protection) require the development of appropriate reforestation approaches. For programmes with limited capital, outcome-oriented approaches will be crucial to maximizing the value of available technological, financial and physical resources.

Current seed sources are generally poor in quality and of insufficient quantity to support large-scale plantation programmes. Past efforts to increase local seed supplies through trial introductions of exotic species and provenances have been unable to meet demand. No accurate estimates of the amount of seed being produced nationally exist, but production in various species must reach 25–35 tons annually if the reforestation target of 100,000ha per year is to be met. Part of this total is currently being collected from existing stands. Although the selection of superior parent trees is continuing, the genetic quality of seeds cannot currently be assured. Superior sources, i.e. seed and clonal orchards, must be established.

The Master Plan has established basic criteria for selecting priority species for planting. These are: i) establishment success must be guaranteed; ii) an adequate amount of quality seed must be available; iii) techniques for raising quality planting stock must be adequately researched; and iv) the species has market potential.

Given these criteria, the choice of species will depend not only on growth characteristics, but also on the condition of the planting site and the state of silvicultural technologies. The ability to coppice and produce rooted cuttings will give a species an advantage from both economic and tree-breeding perspectives. The Master Plan considers only those species which will meet NFP requirements. The criteria limit the use of dipterocarps but only for the period of forest

establishment. After this dipterocarps may be planted. An emphasis has also been put on the use of indigenous species and provenances to avoid the risks arising from the use of exotic species.

The NFP has provided a preliminary list of priority species for reforesting *Imperata* grasslands:

- *G. arborea, Eucalyptus camaldulensis, E. tereticornis, A. mangium, A. auriculiformis, G. sepium, Pithecellobium dulce* and *V. parviflora.*

And for secondary forest sites:

- *S. macrophylla, P. indicus, Pterocarpus vidalianus, E. peltatum, Afzelia rhomboidea, Tarrietia sylvatica, D. dao, Alstonia scholaris, Alnus japonica, P. falcataria* and *E. deglupta.*

It should be noted that, despite the preference given to indigenous species, many of these species are exotics. Their inclusion on the list is justified for marketing reasons or by virtue of their proven performance on particular sites. Additional species will be included after periodic assessments of their appropriateness and an evaluation of the programme.

Pinus caribaea was given priority as a first rotation species in some areas because of its claimed superiority over *Pinus kesiya* (an indigenous species) in growth rate, quality of timber and pulp processing properties. This prioritization is subject to verification under local conditions following the experiences of exotic pine introduction programmes during the 1980s.

Socio-economic issues

Solving the bio-ecological problems of plantation establishment under increasing socio-economic pressures from a growing population is a challenging task. The scarcity of resources in urban areas is pushing a significant portion of the population to the fragile uplands. An estimated 17 million Filipinos live in upland areas, where they engage primarily in upland farming. Efforts are now being made, with some success, to promote sustainable upland farming systems among these people.

Conclusions and recommendations

The main conclusions and recommendations are as follows:

- Identification of priority species and planning of genetic resources conservation strategies for sustainable timber production in the future.

- Timber production remains a major economic activity. Hence guidelines are needed for planning cost-effective strategies for genetic conservation of timber species.

- Establishment of more species and provenance trials using indigenous and local seed sources, while at the same time assessing and rehabilitating existing trials.

- Research to develop adaptable vegetative propagation techniques for priority plantation species, and for other lesser-used species with plantation potential.

- Establishment of continuous data gathering and banking systems to monitor the genetic management of man-made and natural forests.

- The genetic conservation of target species cannot be achieved without effective conservation of all of the conditions required for species survival. It is necessary, therefore, that sites where a given species is found should be incorporated into conservation programmes.

- Genetic conservation and improvement of domesticated species should be regarded as compatible components of sustainable management.

- A holistic approach to *ex situ* conservation which is cost effective and offers better security should be considered.

- Management of genetic resources can be improved by creating a balance between use and conservation. There is an urgent need for research, breeding strategies, conservation strategies and institution building within the framework of socio-political expediency (Burley 1993). There is a dearth of information on tested conservation and breeding strategies, but areas of research can be identified for genetic conservation of timber species.

- Lastly, long-term commitment and support from the government, international agencies and research institutions is needed to implement effective research, breeding and conservation strategies for forest genetic resources.

References

Agroforestry Seeds Circular (1992) Department of Agronomy, UPLB, Laguna.

Budelman, A. (1989) *Paraserianthes falcataria – Southeast Asia's growth champion*. NFT Highlights 89-05, Forest, Farm, and Community Tree Network, Morrilton.

Burley, F. M. (1993) *Tree Breeding Strategies*. Man and the Biosphere Series No. 6. UNESCO/Parthenon Publishing Group, Paris and Carnforth.

Calinawan, A. & Halos, M. (1984) *Tissue culture of Narra (Pterocarpus indicus).* Proceedings. Genetic Conservation and Production of Forest Tree Seeds.

De la Cruz, R. E. (1995) *Application of VAM in the reforestation of submarginal uplands*. Terminal Report, NAS-BOSTID Project.

DENR (1990) *Philippine Biodiversity.* PAWB, DENR, Quezon City.

DENR (1990) *Philippine Master Plan for Forestry - 1990*. FMB, DENR, Quezon City.

DENR (1995) *Department Administrative Order No. 95-09, Regulation of Forest Tree Seed Production, Collection and Disposition.* DENR, Quezon City.

DENR (1998) *Philippine Forestry Statistics 1998*. FMB, DENR, Quezon City.

Fernando, R. (1998) *Survey of botanic gardens*. Unpublished report.

Garcia, M. U. (1998) *Conservation of Forest Tree Species. A State of the Art Review*. ITTO/RCFM, Kuala Lumpur.

Halos, J. (1985) *The reference manual of woody plant propagation from seed to tissue culture*. Varsity Press, Athens, Georgia.

Halos, J. (1992) *Tissue culture of Pinus caribaea*. Unpublished report.

Lapitan, P. G. (1990) *Forestry abstracts Vol. 2, Sociophysical*.

Oporto, D. A. & Umali-Garcia, M. (1998) Clonal propagation of dao: Saving an endangered timber species. *Canopy International* **24 (5)**: 4–10.

Oporto, D. A. (1999) Propagation of kamagong. *Canopy International* **25 (1)**: 10.

Pollisco, M. T. (1995) Guide to the collection and nursery management of wildlings. *Canopy International* **20 (5 & 6)**: 2–4.

Quimado, M. O. (1991) *Multiple shoot formation of Cratoxylon sumatranum*. UPLB, BIOTECH, Laguna.

Quimado, M. O. & Umali-Garcia, M. (1997) Shoot formation in *in vitro* germinated seedlings of *Endospermum peltatum*. *Pterocarpus* **9 (1)**: 71–74.

Schouten, K. (1992) *Checklist of CITES Fauna and Flora, A Reference to the Species in the Appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora*. CITES Secretariat, Lausanne.

Siarot, P. (1991) *Role of symbiotic associations in nutrition of tropical acacias.* Paper presented at Acacia Workshop, 11–15 February 1991, Bangkok, Thailand.

Umali-Garcia, M. (1990a) *Gmelina – A Primer*. Institute of Forest Conservation, UPLB, Laguna.

Umali-Garcia, M. (1990b) *Tissue culture of Paraserianthes falcataria: its relevance to tree improvement*. Biotechnology for Forest Tree Improvement Proceedings. BIOTROP, Bogor.

Umali-Garcia, M. (1995) *Response of Swietenia and Vitex cultivars to rooting by stem cuttings*. Unpublished report.

Umali-Garcia, M. (1996) *Rooting of stem cuttings of Pinus merkusii*. Unpublished report.

Umali-Garcia, M. (1998) Effects of different concentrations of naphthalene acetic acid (NAA) on root production by shoot tip cuttings of Mamalis (*Pittosporum pentandrum*). *Ecosystems Research Digest* **9 (21)**: 1–10.

Umali-Garcia, M. & Melegrito, L. (1995) Vegetative and macropropagation techniques: sustainable development of biotechnology in the tropics. *Canopy International* **10 (6)**: 6–10.

ZBR Foundation (1992) *A Compendium on the Morphology, Phenology, Uses and Economic Importance of Selected Indigenous Forest Tree Species*. ZBR Foundation, Quezon City.

Appendix 1. *Value and use of target, important species. These are priority tree species commonly used in plantations because of their adaptability, and economic value. Source: Agroforestry Seeds Circular (1992); ZBR Foundation (1992).*

Species Name	Value Code[a)]	Present, future or potential use[b)]											Remarks
		ti	po	wo	nw	pu	fo	fd	sh	ag	co	am	
Pterocarpus indicus	1	✓											furniture
Dipterocarpus spp.	1	✓											
Casuarina equisetifolia	2		✓	✓	✓	✓					✓	✓	ornamental dye
Eucalyptus deglupta	2	✓	✓			✓							
Pinus kesiya	2	✓	✓	✓		✓							
Pinus merkusii	2	✓	✓										
Agathis dammara	1	✓											
Albizia procera	2	✓	✓	✓				✓			✓		
Samanea saman	2								✓				ornamental, roadside planting, furniture
Intsia bijuga	2	✓	✓										
Vitex parviflora	1	✓		✓									
Afzelia rhomboidea	2	✓											
Rhizophora spp.	1			✓									
Gmelina arborea	2	✓		✓		✓		✓					
Tectona grandis	2	✓			✓								Dye, medicine, reclamation
Acacia auriculiformis	2	✓		✓	✓	✓		✓		✓	✓		
Acacia mangium	2	✓		✓	✓	✓		✓		✓	✓		
Swietenia macrophylla	1	✓											
Alnus japonica	2				✓				✓		✓	✓	Ornamental
Paraserianthes falcataria	2	✓		✓	✓	✓			✓				
Gliricidia sepium	2			✓	✓			✓	✓		✓		
Dracontomelum dao	1	✓											
Eucalyptus camaldulensis	2	✓		✓	✓	✓			✓				

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 = posts, poles, roundwood; wo = fuelwood; nw = non-wood products (gums, resins, oils, tannins, medicines, dyes, etc.); pu = pulp and paper; charcoal; fo = food; fd = fodder; sh = shade, shelter; ag = agroforestry systems; co = soil and water conservation; am = amenity, aesthetic, ethical values.

Appendix 2. *List of threatened species in the Philippines. These need priority protection based on the IUCN Red List and CITES because they have been identified as vulnerable, endangered and/or critically endangered by forest exploitation. Source: Schouten (1992); Wildlife Resources Division, DENR.*

Family	Common Name	Scientific Name	Conservation Status[a)]
Araucariaceae	Almaciga	*Agathis philippinensis*	IUCN (VU)
Pinaceae	Mindoro pine	*Pinus merkusii*	IUCN (VU)
Podocarpaceae	Igem-dagat	*Podocarpus costalis*	IUCN (VU)
		Podocarpus lophatus	IUCN (VU)
		Podocarpus rotundus	
Annonaceae	Lanutan	*Mitrephora lanotan*	IUCN (VU)
		Orophea palawanensis	IUCN (VU)
Apocynaceae	Lanite	*Wrightia pubescens*	IUCN (VU)
Dilleniaceae	Katmon	*Dillenia philippinensis*	IUCN (VU)
Dipterocarpaceae	Mindanao palosapis	*Anisoptera costata*	IUCN (EN)
	Palosapis	*Anisoptera thurifera*	IUCN (CR)
		Dipterocarpus alatus	IUCN (EN)
	Leaf-tailed panau	*Dipterocarpus caudatus*	IUCN (CR)
	Panau	*Dipterocarpus gracilis*	IUCN (CR)
	Apitong	*Dipterocarpus grandiflorus*	IUCN (CR)
	Hasselt panau	*Dipterocarpus hasseltii*	IUCN (CR)
	Malapanau	*Dipterocarpus kerrii*	IUCN (CR)
	Broad-winged apitong	*Dipterocarpus kunstleri*	IUCN (CR)
	Hagakhak	*Dipterocarpus validus*	IUCN (CR)
	Manggachapui	*Hopea acuminata*	IUCN (CR)
	Basilan Yakal	*Hopea basilanica*	IUCN (CR)
	Mindanao narek	*Hopea brachyptera*	IUCN (CR)
	Narek	*Hopea cagayanensis*	IUCN (CR)
	Dalingdingan	*Hopea foxworthyi*	IUCN (VU)
	Yakal-kaliot	*Hopea malibato*	IUCN (CR)
	Yakal-magasusu	*Hopea mindanensis*	IUCN (CR)
	Gisok-gisok	*Hopea philippinensis*	IUCN (CR)
	Yakal-saplungan	*Hopea plagata*	IUCN (CR)
	Quisumbing gisok	*Hopea quisumbingiana*	IUCN (CR)
	Samar gisok	*Hopea samarensis*	IUCN (CR)
	Bagtikan	*Parashorea malaanonan*	IUCN (CR)
	Almon	*Shorea almon*	IUCN (CR)
	Yakal	*Shorea astylosa*	IUCN (CR)
	White lauan	*Shorea contorta*	IUCN (CR)
		Shorea falciferoides	IUCN (CR)
	Yakal-yamban	*Shorea falciferoides* ssp. *falciferoides*	IUCN (CR)
	Manggasinoro	*Shorea globifera*	IUCN (CR)
		Shorea philippinensis	IUCN (CR)
	Guijo	*Shorea guiso*	IUCN (CR)
	Kalunti	*Shorea hopeifolia*	IUCN (CR)
	Manggasinorong-tilos	*Shorea koordersii*	IUCN (VU)
	Yakal-malibato	*Shorea malibato*	IUCN (CR)
	Red lauan	*Shorea negrosensis*	IUCN (CR)
	Tiaong	*Shorea ovata*	IUCN (EN)
	Mayapis	*Shorea palosapis*	IUCN (CR)
	Malaanonang	*Shorea polita*	IUCN (VU)
	Tanguile	*Shorea polysperma*	IUCN (CR)
	Malayakal	*Shorea seminis*	IUCN (CR)
	Kaladis narig	*Vatica elliptica*	IUCN (CR)
	Narig	*Vatica mangachapoi*	IUCN (EN)
	Narig-laot	*Vatica maritima*	IUCN (EN)
	Mindanao narig	*Vatica odorata* spp. *mindanensis*	IUCN (EN)

Appendix 2. *(continued)*

Family	Common Name	Scientific Name	Conservation Status[a)]
	Thick-leafed Narig	*Vatica pachyphylla*	IUCN (CR)
Ebenaceae		*Diospyros blancoi*	IUCN (VU)
	Kamagong	*Diospyros philippinensis*	IUCN (EN)
Euphorbiaceae	Hamindang	*Macaranga bicolor*	IUCN (VU)
	Baguilumbang	*Reutealis trisperma*	IUCN (VU)
	Balakat-gubat	*Sapium luzonicum*	IUCN (VU)
Fagaceae	Mangasiriki	*Lithocarpus ovalis*	IUCN (VU)
Laureaceae	Batikuling	*Litsea leytensis*	IUCN (VU)
Leguminosae	Tindalo	*Afzelia rhomboidea*	IUCN (VU)
	Akle	*Albizia acle*	IUCN (VU)
	Malaipil	*Intsia acuminata*	IUCN (VU)
	Narra	*Pterocarpus indicus*	IUCN (VU)
	Supa	*Sindora supa*	IUCN (VU)
Meliaceae	Malasantol	*Sandoricum vidalii*	IUCN (VU)
	Kalantas	*Toona calantas*	IUCN (DD)
Myristicaceae	Agusan-duguan	*Myristica agusanensis* ssp. *squamulosa*	IUCN (VU)
	Duguan	*Myristica philippinensis*	IUCN (VU)
Myrtaceae	Malabayabas	*Tristania decorticata*	IUCN (VU)
	Mangkono	*Xanthostemon verdugonianus*	IUCN (VU)
Rhamnaceae	Balakat	*Zizyphus talanai*	IUCN (VU)
Sapotaceae	Red nato/nato	*Palaquium luzoniense*	IUCN (VU)
Verbenaceae	Philippine teak/bunglas	*Tectona philippinensis*	IUCN (EN)
	Molave	*Vitex parviflora*	IUCN (VU)

[a)] CR = Critically endangered; EN = Endangered; VU = Vulnerable; DD = Data deficient.