

Status of forest genetic resources conservation and management in Thailand

Vichien Sumantakul

Director, Silviculture Research Division, National Park, Wildlife and Plant Conservation Department, Bangkok, Thailand

Introduction

Thailand is situated in Southeast Asia, between the latitudes 5° and 20° N and longitudes 97° and 106° E with a total land area of 515 113 km² or about 52 million ha. The total forest area is 172 050 km² or approximately 33.4% of the country's total area (RFD 2001). This includes 164 865 km² of natural forest, 3551 km² of reforestation area and 3633 km² of secondary growth. The range of elevation is from sea level up to 2200 m. Climatic conditions vary from the lowland humid tropics to alpine and subtropical types. Annual rainfall varies from below 1000 mm in the north and the northeast to above 2500 mm in the south.

Thailand is topographically divided into five regions: the north, northeast, central, east and south. The northern region, which is hilly and mountainous, lies on the fringe of the Himalayan foothills, which give way to the plains of the northeast. The Chao Phraya River and its four main tributaries have formed the alluvial floodplain of the central region. The natural vegetation is extremely diverse. Thailand is one of the richest countries of the world in biological resources. This is attributed to the biogeographical location of the country, which is at the junction of the three main floristic regions, namely the Indo-Burmese, Indo-Chinese and Malesian regions (Smitinand 1989, cited by Boontawee *et al.* 1995). The Indo-Burmese floristic region prevails in the northern, northwestern and western parts of the country. The Indo-Chinese floristic region is found in the northeast, whereas the Malesian floristic type is found in the southern peninsular and in the eastern parts of the country. Therefore, the natural forest vegetation of Thailand ranges from upland pine forests on the border with Lao PDR and Myanmar in the north to lowland rain forests in the far south. It is estimated that more than 10 000 plant species make up the natural vegetation of the Kingdom (RFD 1996).

Forestry sector in Thailand

The majority of forestlands in Thailand is an asset of the state. At the present the government agencies responsible for forests are the Royal Forest Department (RFD) and the National Park, Wildlife and Plant Conservation Department (DNP). Since the founding of the Royal Forest Department in 1896 exploitation of timber, especially teak (*Tectona grandis* L.) from natural forests was carried out through a silvicultural selection practice with a minimum girth system. Teak trees with girth at breast height exceeding 212 cm were allowed to be harvested. For non-teak trees different minimum girth limits were set (RFD 1996). The silvicultural practices used in the past did not cause severe depletion of the forests. However, the country's forests have been subject to clearance and degradation for many years, though the current situation is more stable. Forests covered more than half of Thailand's land area in 1961 but they had been reduced to just over 33.4% by 2001 (RFD 2001). Demand for land for various uses, including subsistence farming and commercial agriculture, has been the main cause for deforestation. Rapid population growth has also elevated the demand for wood products and the consequent exploitation pressure on forests. Deforestation has had a severe impact on Thailand's environment and economy. Between 1981 and 1991 the rate of forest destruction was about 515 000 ha per year.

In an attempt to halt the loss and degradation of forests, the Government of Thailand imposed a logging ban in natural forests in 1989 and introduced a master plan for reforestation. The plan aims to bring back the forest cover to 40% of the nation's territory within the next 40 years. The aimed target will consist of protected forests (25%) for nature conservation, recreation and environmental protection and economic forests (15%) for

production of timber and non-timber forest products (Sutthisrisinn and Noochdamrong 1998).

Scarcity of wood as well as lucrative wood prices have not stopped illegal logging despite the logging ban. Villagers also continue to clear new forest areas for agriculture. National reforestation schemes have to date had little discernible impact on deforestation. While the area of forests continues to decline, difficulties have arisen in promoting large-scale reforestation programmes. The area of plantations was about 1 139 982 ha in 2001. Between 1981 and 1990 the annual rate of plantation establishment was about 40 000 ha – less than 10% of the deforestation rate (RFD 2001). In recent years, the annual rate of plantation establishment has risen to 150 000 ha, about half of which is within the private sector. Reforestation activities have taken place mainly in the north and northeast regions of the country.

Thailand adopted a national forest policy in December 1985. The policy signals the dangers of environmental deterioration and the need to sustain wood supply in the future. These two main aspects are being addressed through improved protection of remaining natural forests, and a more dynamic approach towards plantation forestry. Private plantation activities have also been emphasized.

Tree planting has been a feature of Thailand's National Economic and Social Development Plans since 1961. Planting is carried out by the public as well as the private sector. The public sector comprises of RFD and state enterprises. In the private sector, planting is done by companies engaged in the establishment of tree plantations for industrial purposes and by community associations and individual farmers establishing woodlots and integrated land use systems. The private sector is expected to dominate tree-planting efforts in the future.

During the past 35 years, Thailand has gained a considerable amount of knowledge in tree improvement of a number of priority species. The genetic resources of several species have been conserved and developed. Twenty-three seed exchange zones have also been demarcated. It is inevitable that the present and future planting programmes will use a more diverse range of species, including many indigenous tree species. Conservation of forest genetic resources (FGR) of indigenous species must be extended. The availability of appropriate planting material of these species will enhance any tree planting effort, whether in multi-purpose forests, conservation forests or economic forests. These actions will contribute to environmental restoration and strengthening of the national economy, which in turn will contribute to the development of the region.

Conservation of forest genetic resources

Forest types of Thailand

The forests of Thailand have been classified into nine types:

- i) Tropical evergreen forest
- ii) Mixed deciduous forest
- iii) Dry dipterocarp forest
- iv) Swamp forest
- v) Inundated forest
- vi) Beach forest
- vii) Pine forest
- viii) Bamboo forest
- ix) Mangrove forest

Table 1 below shows the types of forests in different regions in 2000.

Table 1. Forest areas by type and region in 2000 (in km²) (RFD 2001)

Forest type	North	Northeast	Central	East	South	Total
Tropical Evergreen	19 833	7658	4210	6214	14 634	52 589
Mixed Deciduous	66 291	8889	14 439	1159	12	90 791
Dry Dipterocarp	8062	7929	698	24	–	16 713
Swamp	–	–	1	1	287	289
Inundates	–	362	–	–	4	366
Beach	–	–	–	–	114	114
Pine	93	42	–	–	1	136
Bamboo	158	380	771	107	10	1426
Mangrove	–	–	120	227	2094	2441
Total forest area	94 477	25 260	20 239	7732	17 156	164 865
Total land area	172 271	167 715	67 216	36 509	71 402	515 113

Background related to forest conservation

Conservation movements in the United States and Canada raised public awareness in Thailand and in 1941 the Forestry Act was passed. This first Act concerned with logging operations and collection of non-wood forest products, timber stamp, sawn wood control, penal provisions, transitory provisions and other miscellaneous items. The Forestry Act was followed by the National Park Act 1961, which covers the determination of national park lands, national park committee, protection and maintenance of national parks, penal provisions and transitory provision. The National Reserved Forests Act 1964 includes the determination of national reserved forests, control over and maintenance of the national reserved forests, penal provisions and transitory provisions. In 1992, the Wildlife Preservation and Protection Act was passed. This Act concerns with general provision, the national wildlife preservation and protection committee, hunting, propagation, possessing and trading in the wildlife, their carcasses and carcass products, importing, exporting, passing through and moving wildlife as well as wildlife check-points, public zoos, areas and places under prohibition of wildlife hunting, the competent officer, penal provisions and transitory provisions.

The system of protected areas in Thailand was established in 1962 with the designation of Khao Yai as the country's first national park. By 2001, the system has expanded to include 102 national parks with the total area of 52 263 km², 67 forest parks (in total 870 km²), 55 wildlife conservation areas (34 897 km²) and 48 non-hunting areas (2379 km²). Additional parks and wildlife conservation areas are being proposed for incorporation into the system. These protected areas function as *in situ* conservation areas and FGR are generally well preserved because laws and regulations are strict. Furthermore, botanical gardens and arboreta have also been established. National conservation areas in Thailand are presented in Table 2 below.

Table 2. Natural conservation and recreation areas in Thailand, 1997–2001 (km²) (RFD 2001)

	1997		1998		1999		2000		2001	
	Units	Area	Units	Area	Units	Area	Units	Area	Units	Area
National parks	82	42 332	87	44 182	96	48 927	102	52 226	102	52 263
Forest parks	66	860	65	867	66	851	68	852	67	870
Wildlife conservation areas	44	32 011	46	32 671	48	33 433	53	34 848	55	34 897
Non-hunting areas	43	2972	44	3101	49	3304	49	3304	48	2 379
Botanical gardens	15	56	15	56	15	58	15	58	15	58
Arboreta	49	30	53	34	53	35	54	36	54	36
Total	299	78 261	310	80 911	327	86 608	341	91 324	341	90 503

Since the 8th National Economic and Social Development Plan (1997–2001) Thailand has included conservation and rehabilitation of natural resources into a development plan to protect both the urban and rural environments. Local people as well as community organizations have been urged to play a more active role in the management of natural resources and the environment. Economic instruments have been used for controlling and supervising utilization and management in this respect. Furthermore, more efficient use has been promoted so that natural resources could be used to the greatest possible advantage for the economy as a whole, while minimizing the negative environmental impacts. Thailand has also played a greater role in regional and international levels in natural resources management.

Objectives of the Plan were: i) to ensure that utilization of natural resources is counter-balanced by rehabilitation and protection programmes and ii) to promote more effective management with the collaboration of different sectors of society, so as to achieve greater balance in ecosystems and the environment. Opportunities would be provided for local people and organizations to play a greater role in natural resources and environmental conservation within their own communities, with support from the public sector, academic experts, NGOs and business enterprises.

Strategies for natural resources and environmental management

The National Economic and Social Development Plan proposed the following major strategies to achieve the objectives set for natural resources and environmental management:

A. Rehabilitation of natural resources and environments

- Manage the rehabilitation of degraded and abandoned land to increase agricultural output and to minimize negative environmental impacts. Attention should be given to former mining sites, former shrimp ponds and farmlands abandoned because of unfavourable soil conditions, such as soil salinity, soil acidity and coastal-type soil.
- Reduce the volume and distribution of pollution in local environments by proper management of various types of pollution, such as community and industrial waste and hazardous substances so that they do not pose a threat to public health and living conditions.
- Support the establishment of a comprehensive waste treatment and disposal system, comprising of comprehensive wastewater treatment and garbage disposal.
- Promote the development of waste disposal technology and green technologies to be applied to the production processes to minimize environmental impacts. Such technology will include prototypes that may be put into commercial production. In addition, promote analysis and evaluation of technology for appropriate environmental management that can be transferred for effective application.

B. Promotion of the participation of local people and communities in natural resource and environment management

- Expand the public sector's role in promoting wider participation in natural resource and environmental management.
- Develop information networks on natural resource and environmental conservation.
- Provide more opportunities for local communities and people to participate.
- Proper management of natural resources and the environment.

C. Improving natural resource and environment management

- Establish systematic management of water resources.
- Coordinate land use policy and management consistent with and appropriate for the development potential of each area.
- Ensure sound management of community environment and green areas.
- Conserve natural and heritage sites.
- Promote a holistic, systematic approach to natural resource management.
- Improve systems for the prevention and relief of hardship and suffering caused by natural disasters.

- Improve the efficiency of public agencies involved in natural resource management, including the control and resolution of environment problems.
- Enlarge the Kingdom's role in international cooperation on environmental protection.

Past and present activities in the field of conservation, utilization and management of forest genetic resources

Thailand has long been involved in the process of FGR conservation. The process was started with Thai-Danish cooperation in tree improvement, i.e. teak in 1965 and pine and fast growing species improvement in 1969 (Sumantakul 2001). Good progress in the improvement, conservation and utilization activities have been made since then. Over the years, large teak plantations that have been developed as seed stands, provenance and clonal test plots as well as seed orchards, which were managed by the teak improvement programme, have established a broad base for future genetic replenishment. However, the above stands and plots were not established for the explicit purpose of *ex situ* conservation.

Ex situ conservation of tropical pines was initiated in 1973. The programme included both indigenous and selected Central American tropical pine species. Approximately 800 ha of provenance *cum* seed stands have been established in the highlands of northwest Thailand. This also included provenance stands for *Eucalyptus camaldulensis*. *In situ* conservation activities were initiated with a lowland source of *Pinus merkusii* in 1977. *Ex situ* conservation of eight hardwood species was initiated in 1987 (FORGENMAP 2002).

In situ conservation of lowland *Pinus merkusii*

Due to changes in circumstances, *Pinus merkusii* is not used as a plantation species in Thailand at the present. However, the species is suitable for reforestation of poor and degraded soils as well as for community forests.

The natural stands, especially in the northeastern part of the country, have been heavily exploited as a source of resin and fire sticks. Many good stands are fragmented and declining. The lowland stands that showed the best performance in provenance trials are threatened with extinction. In order to conserve the gene pool, two populations from different parts of the distribution area have been protected and managed. These are at Nong Khu, Surin province that started in 1977 with an area of 100 ha. The mixed dry dipterocarp/dry evergreen/lowland *P. merkusii* stand at Khong Chiam in Ubon Ratchathani, with an area of about 960 ha, was also protected in 1987 and is managed in order to conserve the entire ecosystem. The objectives of *in situ* conservation of *Pinus merkusii* include:

- To secure its ability to evolve and adapt to the environmental changes
- To maintain the basis for future selection and breeding activities as well as for seed sources with broad genetic base

Future conservation programme of lowland *Pinus merkusii*

Identification of populations

The following specific criteria shall be applied for the identification of conservation stands of *Pinus merkusii*:

- Genecological variation: selection can be based on knowledge of variation in specific characters among stands, e.g. morphological traits and genetic diversity assessed by molecular markers.
- Population size: must be large enough to conserve the genetic variation and provide conditions for adequate regeneration.
- Legal conservation status: legally protected occurrences preferred.
- Socioeconomic context: areas without serious human pressure, i.e. in protected areas and reserved forest areas where local people can participate in the management.
- Economic or commercial importance.
- Management options and costs of protection and management: intervention to ensure adequate regeneration should be possible.

Preliminary selection of stands for *in situ* conservation of *Pinus merkusii*

Based on the above criteria, stands in each genecological zone have been proposed for *in situ* conservation as shown below in Table 3. The details of each genecological zone have been described by Theilade *et al.* (DFSC 2000).

Table 3. *In situ* conservation stands of *Pinus merkusii* in the different genecological zones in Thailand (DFSC 2000)

Genecological zone #	Name and location of the stand
1	Paa Chumchon Khao Son, Phetchaburi
2	Phu Toei National Park, Suphan Buri
3a	Mae Sod, Tak
3b	Om koi Plateau, Omkoi; Huay Bong, Hod, Chiang Mai
3c	Doi Phra Luang, Tak
4	Khun Yuam, Mae Hong Son
5	Ban Wat Chan, Mae Cham, Chiang Mai
6	Doi Phu Kha, Nan
7a	Thung Salaeng Luang National Park, Lom Sak, Phitsanulok
7b	Phu Kradeung, Loei
8	Khong Chiam and Buntharik, Ubon Ratchathani

Possible conservation measures and management options

Some stands in each genecological zone have been proposed as *in situ* conservation stands. However, these measures are unlikely to be sufficient to safeguard the genetic base of *Pinus merkusii*. Additional conservation measures and management options in each zone are proposed and tabulated below in Table 4.

Table 4. Conservation measures for *Pinus merkusii* in Thailand

Genecological zone #	Conservation measure	Management option
1	Establishment of <i>ex situ</i> stands by using planting material (seedling or grafting) from 3 populations.	Control (if possible stop) cutting trees, resin tapping and fire stick chipping.
2	–	Protect against uncontrolled forest fires in order to enhance regeneration. Raise seedlings or wildlings in the nursery for enrichment planting.
3–7	Monitoring and applying active conservation efforts to the selected stand in order to safeguard particular stands.	Control/eliminate fire stick cutting and resin tapping.
4–5	Establish forest areas as Managed Nature Reserves.	Establish a sustainable management system of the forest jointly among foresters, local NGO and local hill tribes.
8	Establish <i>ex situ</i> / <i>circa situ</i> stands with seed collected from a broad representation of remaining unrelated phenotypes. Create a large pool containing a mix of all lowland sources.	Protect the stands against forest fires in order to enhance regeneration through the removal of inflammable materials around seedlings, followed by controlled burning. Raise seedlings or wildlings in the nursery for enrichment planting. Control fire stick cutting and resin tapping. Engage communities in an active “Partnership in conservation” Programme.

Final selection of stands where active conservation efforts should be implemented

It was confirmed and recommended that the lowland stands of *P. merkusii* at Khong Chiam, Nong Khu and Buntharik in north-eastern Thailand should be conserved as *in situ* conservation areas. Furthermore, the lowland stand at Paa Chumchon Khao Son in the southwest should be surveyed and sought to be conserved. *Ex situ* conservation should be considered as a complementary conservation strategy for four stands.

Ecosystem conservation

The rapid depletion of natural forests in Thailand during the past four decades caused a tremendous loss of genetic diversity of plants, animals and micro-organisms through the reduction of forest areas. Many tree species are endangered and some are rare at present. Therefore, conservation of ecosystems is vital for the existence of economically important plant and tree species for potential future use, including various fields of research, recreation, and tree improvement as well as mitigation of climate change.

Realizing the importance of ecosystem diversity, and to comply with Convention on Biological Diversity (CBD), *in situ* conservation of FGR through "ecosystem conservation" has been initiated in Thailand in 1999.

Objectives of ecosystem conservation

Objectives of ecosystem conservation include:

- Maintain the natural habitats of economically important species, endangered species as well as rare species and allow for natural regeneration for the diverseness of their genetic diversity
- Utilize the stands as gene pools for selection and tree improvement
- Use the sites for studies on genetic diversity, population evolution, ecosystem, flowering biology and seed production
- Serve as habitats for wild animals, plant species, undergrowth and medicinal plants.
- Serve as sites for field tours and recreational purposes
- Maintain the balance of nature and mitigation of climate changes

Methodology of ecosystem conservation

The Silviculture Research Division, RFD has initiated the Ecosystem Conservation Programme. At present, eight forest types in the national reserve forests and national parks and wildlife sanctuaries have been selected within the country. Each type is represented by three to four locations for ecosystem conservation and 15 locations have been marked out and mapped. The number of species has been counted from four permanent sample plots of 100x100 m in size. Line plot design has been used for counting in mangrove forests. Other studies, such as density, frequency, dominance and relativity studies will be done in the near future. Table 5 below shows accomplishments in the past three years.

Table 5. Details of the Ecosystem Conservation Programme in Thailand (Anon 2002)

No.	Forest type	Location	Area (ha)	Plot no.	No. of species
1.	Wet evergreen	Khao Luang National Park, Lansakar district, Nakhon Si Thammarat	48/64	1	107
				2	115
				3	95
				4	98
2.	Wet evergreen	Hala-Bala Wildlife Sanctuary, Sukirin district, Pattani	400	1	116
				2	126
				3	130
				4	100
3.	Wet evergreen with <i>Hopea odorata</i>	Vieng Kosai National Park, Wang Chin district, Phrae	80	1	72
				2	58
				3	55
				4	63
4.	Mixed deciduous with teak	Mae Yom National Park, Long district, Phrae	96	1	47
				2	66
				3	61
				4	66
5.	Mixed deciduous with teak	Um Pang Wildlife Sanctuary, Um Pang district, Tak	560	1	30
				2	41
				3	36
				4	39
6.	Mixed deciduous with teak	Mae Yuam National Reserve, Mae Sarieng district, Mae Hong Son	760	1	45
				2	38
				3	56
				4	46
7.	Dry evergreen	Mae Salid-Pong Daeng National Reserve, Ban Tak district, Tak	480	1	76
				2	70
				3	66
				4	79
8.	Dry evergreen	Khao Pu Luang National Reserve, Wang Namkhiew district, NaKhon Ratchasima	160	1	60
				2	56
				3	48
				4	61
9.	Dry evergreen	Klang Aow Forest Park, Bang Sapan district, Prachuab Khiri Khan	192	1	53
				2	38
				3	57
				4	63
10.	Pine with Quercus <i>P. kesiya</i> <i>P. merkusii</i>	Nam Naoh National Park, Nam Naoh district, Phetchabun	480	1	17
				2	26
				1	36
11.	Dry dipterocarp	Phupan National Park, Muang district, Sakon Nakhon	160	1	32
				2	35
12.	Dry dipterocarp	Huay Mae Dee Forest Protection Unit, Huay Kha Khaeng Wildlife sanctuary, Ban Rai district, Uthai Thani	104	1	49
				2	52
				3	34
				4	41
13.	Dry dipterocarp with pine	Phu Khao Kaew and Dong Pak Chom forests, Pak Chom district, Loei	480	1	26
				2	19
				3	19
				4	20
14.	Peat swamp	Bang Nara Watershed forest, Sungai Kolok district, Narathiwat	160	1	43
				2	41
15.	Mangrove	Kung Kraben forest, Thamai-nayai-arm district, Chantaburi	128		8

Ex situ conservation

Thailand joined the FAO-coordinated *ex situ* FGR conservation programme in 1973. Some exotic tree species have been conserved in *ex situ* conservation stands at many locations in the country. Appendix 1 shows details of the *ex situ* conservation stands in Thailand.

Ex situ conservation of selected hardwood species

The depletion of forest areas in the past four decades caused a shortage of timber production of dipterocarps and various tree legumes. Wood for general construction as well as for furniture and indoor flooring is becoming scarce. The species are endangered and genetic material is needed in the planting programmes. To ensure a good quality seed supply as well as to safeguard base populations for future breeding programmes, the establishment of conservation stands for important dipterocarp species and tree legumes has been undertaken. A programme for *ex situ* conservation of eight major timber species was implemented during 1989–93 by the RFD in collaboration with the Danida Forest Seed Centre (DFSC). Danida provided some budget and technical assistance while the research field stations of the RFD undertook the maintenance of the stands. However, it should be noted that no detailed genecological studies were made before the stands were established. Objectives of the programme included:

- Safeguarding the threatened gene pool of specific species
- Development of base populations with a broad genetic base for future selection for tree improvement programmes
- Development of documented and well-managed sources of seed supplies for plantation programmes in the future
- Provision of material for further genetic and silvicultural studies as well as investigations on management of FGR

Species for the *ex situ* conservation programme included eight major timber species in the families Dipterocarpaceae (*Dipterocarpus alatus*, *Hopea odorata* and *Shorea roxburghii*) and Leguminosae (*Azelia xylocarpa*, *Dalbergia oliveri*, *D. cochinchinensis*, *Pterocarpus macrocarpus* and *Xylia xylocarpa* var. *kerrii*).

Locations

The *ex situ* conservation stands were established at the following sites: Silviculture Research Centre No.3 (Kanchanaburi), Silviculture Research Centre No. 5 (Kamphaeng Phet), Sakaerat Gene Conservation Station (Nakhon Ratchasima), Phitsanulok Experimental Station (Phitsanulok), Nong Khu Gene Conservation Station (Surin), and Ubon Ratchathani Gene Conservation Station (Ubon Ratchathani). The stations' responsibility was to undertake seed source surveys, selection of mother trees, seed collection, seedling preparation, site preparation, planting, maintenance and stand protection.

Five endangered seed sources with promising records from each species were surveyed and evaluated for their potential based on genetic variation, state of degradation and phenotypic appearance. Better than average phenotypes of 30 trees were selected and marked for seed collecting. Seeds sufficient to produce at least 500 seedlings were collected on an individual tree basis. The family identity by means of tagging of each seedling was maintained throughout the nursery phase. Seedlings were root pruned as required and hardened prior to field planting.

Seedlings of the different families were arranged to ensure a uniformly balanced family mix. Seedlings were planted in blocks of species and sources. For each individual source, the target area was set at 10 ha. 2x4m spacing was applied in planting. The total area of conservation stands planned for six locations was 400 ha. The aim was to develop each species in 4–5 sources of each minimum 30 families, in total 120–150 unrelated phenotypes. Plantings were established as monoculture plantations and as time passed the weaknesses of monocultures became obvious: poor vigour, susceptibility to diseases and pest attacks etc. In particular, species originating from mixed tropical forests proved vulnerable. The

idea of mixed species planting has been gaining greater acceptance in Thailand and elsewhere in recent years.

A summary of the status of the various gene conservation stands is shown in Table 6 (FORGENMAP 2002).

Table 6. Summary of gene conservation stands in different research stations in Thailand in 1999

Species	Site no.										TOTAL	
	1		2		3		4		5		Area (ha)	No. of trees
	Area (ha)	No. of trees	Area (ha)	No. of trees	Area (ha)	No. of trees	Area (ha)	No. of trees	Area (ha)	No. of trees		
<i>Dipterocarpus alatus</i>	16	30	26	14	10	–	10	–	–	–	62	44
<i>Dalbergia cochinchinensis</i>	16	25	10	–	10	–	10	–	10	13	56	38
<i>Xylia xylocarpa</i> var. <i>kerrii</i>	20	30	10	30	10	–	–	–	10	25	50	85
<i>Pterocarpus macrocarpus</i>	16	25	10	30	10	–	–	–	10	26	46	81
<i>Shorea roxburghii</i>	16	25	10	–	10	–	–	–	–	–	36	25
<i>Azelia xylocarpa</i>	16	25	4	25	10	–	–	–	10	28	40	53
<i>Dalbergia oliveri</i>	20	30	4	–	10	–	–	–	–	–	34	30
<i>Hopea odorata</i>	16	25	26	5	10	–	–	–	–	–	52	30
Total											356	386

Remark: Site 1: Silviculture Research Centre No. 5

Site 2: Sakaerat Gene Conservation Station

Site 3: Nong Khu Gene Conservation Station

Site 4: Ubon Ratchathani Gene Conservation Station

Site 5: Silviculture Research Centre No. 3

Tree improvement activities

Tree improvement activities in Thailand began in 1965 with teak (*Tectona grandis*) with assistance from the Danish International Development Agency (Danida). This work was extended to tropical pines and eucalypts in 1969. However, plantation programmes in the country led to the establishment of national tree seed centres with the assistance of the Danish Cooperation for Environment and Development (DANCED) in 1997. Several seed production areas and seed orchards for the species have been established in the country.

Socioeconomic conditions and issues related to the conservation, utilisation and management of forest genetic resources

It is estimated that 60% of Thai citizens are farmers. Therefore, Thailand is a predominantly agricultural country. However, industrialization of agriculture is limited, consisting mainly of primary processing units. Forests are used mainly as a source of products for construction timber, posts and poles, fuelwood, food, fodder, shade and shelter, as well as services such as recreation and soil and water conservation.

Rapid population growth in the past, modern development and uncontrolled human activities are the main causes of the dwindling of the forests. However, the establishment of national parks, forest parks and wildlife sanctuaries has secured the conservation of these resources. Those areas are under more strict laws and regulations (the National Park Act 1961 and Wildlife Preservation and Protection Act 1992). Table 7 below shows changes in regional forest area between 1988 and 2000. Natural conservation and recreational areas as of 1997–2001 are shown in Table 2.

Table 7. Changes in regional forest area between 1988–2000 (km²) (RFD 1999; RFD 2001)

Region	1988	1991	1993	1995	1998	2000*
North	80 402	77 143	75 231	73 886	73 057	98 059
North-east	23 693	21 799	21 473	21 265	20 984	26 955
Central	17 244	16 616	16 408	16 288	16 049	21 426
East	7 834	7 691	7 634	7 591	7 507	8 232
South	14 630	13 449	12 808	12 455	12 125	17 378
Total	143 803	136 698	133 554	131 485	129 722	172 050
	(28.03%)	(26.64%)	(26.03%)	(25.62%)	(25.28%)	(33.40%)

* Area includes forest plantations and secondary growth forests.

Though the Royal Thai Government imposed a total logging ban in the natural forest in 1989, deforestation is still continuing, however, with a slower pace than between 1973 and 1985 when it was estimated to be 1% each year.

Afforestation and reforestation activities

The first plantation activities in Thailand were initiated in 1906 with teak in the north. Thereafter small areas were planted annually up to 1960, reaching a total of approximately 8500 ha of which 70% was planted with teak.

Since 1961, the planting programme has gradually been increased, covering a total of 633 000 ha by 1986. From 1981 onwards the annual planting programme has covered about 71 000 ha of which 38 000 ha are private plantings. Main regions for planting activities have been the North (55%) and Northeast Thailand (18%). However, losses of plantation areas have occurred due to encroaching by farmers, fires and natural disasters, though record of exact area lost is not available.

Tree planting programme has been a permanent item of the National Economic and Social Development Plans since 1961 (see Table 8). The target areas have gradually expanded, but, the actual planting programmes have not been able to meet the targets. At that time (1961) the target was to keep 50% of the total area of the country as forests.

Table 8. The Forest Plantation Programme in Thailand according to the National Economic and Social Development Plans (NESDP 1961-2006)

Plan number	Total afforestation in 5-year plan periods (ha)
First Plan (1961–66)	12 480
Second Plan (1967–71)	112 000
Third Plan (1972–76)	194 000
Fourth Plan (1977–81)	400 000
Fifth Plan (1982–86)	240 000
Sixth Plan (1987–91)	Not specified but aimed at 40% forest cover
Seventh Plan (1992–96)	Not specified but aimed at 25% of conservation areas and 80 000 ha of community forest
Eight Plan (1997–01)	Not specified but aimed at 25% of conservation areas
Ninth Plan (2002–06)	Not specified but aimed at 25% of conservation areas

Thailand adopted a National Forest Policy in December 1985 with the aim to stop deterioration of the environment and to maintain a sustained wood supply for the future. In this policy, more emphasis is put to improve protection of the remaining natural forests, and plantation forestry. Private afforestation activities are strongly encouraged. This national policy adopted a long-term target for forest coverage equivalent to 40% of the country's land area.

A Master Plan for Reforestation was made because of the needs to address the serious problem of deforestation and to reach the desired target for forest coverage. The long-term objectives of the Master Plan are:

1. To create improved wood production based on sustained yield to cover domestic demands as well as export needs
2. To reduce further environmental degradation and, if possible, improve the situation by using forests for protection against soil erosion and flooding

The targeted forest cover of 40% is expected to be reached in 2031. The targets of the Master Plan are shown in Table 9 below.

Table 9. Targets of the 1991–2031 Master Plan (RFD 1993)

Land category	Present status (1991)		Target 2031	
	mill. ha	%	mill. ha	%
Conservation forest	8.72	17	7.70	15
Production forest	5.64	11	12.82	25
Total forest area	14.36	28	20.52	40
Non-forest area	36.95	72	30.79	60
Total land area	51.31	100	51.31	100

The species to be planted are anticipated to be teak, indigenous hardwood species, *Acacia* species, eucalypts species, *Casuarina* species, neem, rubber, lowland pine, highland pine, and mangrove species. Conservation of genetic resources of the species for future uses is, therefore, of utmost importance in Thailand. Demand for superior seeds and improved planting materials will be very high. Good policy for the utilization and management of FGR shall lead to the success of the planting programmes.

Identification of national priorities

Criteria and justification for selecting the priority species

Determining priority species for genetic resources conservation needs careful consideration. Limited resources are available for conservation activities in Thailand. However, the main criteria for assessing which tree species ought to be prioritised for inclusion in forest genetic conservation and management programme are described below (FORGENMAP 2002):

1. Socioeconomic importance

The commercial importance of the species and the extent to which it is in demand for planting are important considerations. The importance of species for maintaining ecosystem functions and services, such as watershed protection may also be taken into account. A ranking system for these criteria is shown below:

- 5 Highest priority – very widely planted
- 4 Very high priority – widely planted in some regions
- 3 High priority – widely planted in at least one region
- 2 Moderated priority – some planting in at least one region
- 1 Low priority – limited planting in at least one region
- 0 Not planted
- n.a. Unknown/not sure

2. Level of within-species variation

Species with higher levels of genetic diversity will require increased conservation effort. In Thailand, the following ranking system has been developed for within-species variation:

- 5 Very widespread species in 3–4 regions; high level of genetic variation reported or inferred
- 4 Widespread species present in 3–4 regions; moderately high level of genetic variation reported or inferred
- 3 Intermediate; present in two regions; moderate level genetic variation reported or inferred

- 2 Localized species (several to many populations in one region)
- 1 Very limited variation (only 1–2 populations found in limited geographic area)
- n.a. Unknown/not sure

3. Level of threat or risk

Species with populations at risk or under threat from any cause will warrant greater conservation action. The World Conservation Union (IUCN) has set the following risk or endangeredness categories for species:

- Critically Endangered: A taxon is *critically endangered* when it is facing an extremely high risk of extinction in the wild in the near future.
- Endangered: A taxon is *endangered* when it is not critically endangered but is facing a very high risk of extinction in the wild in the near future.
- Vulnerable: A taxon is *vulnerable* when it is not critically endangered or endangered but it is facing a high risk of extinction in the wild in the medium-term future.
- Lower Risk: A taxon that has been evaluated and found not to be threatened (as above). Includes three sub-categories:
 - *Conservation dependent*: A taxon, which is in the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon becoming threatened within a period of five years
 - *Near threatened taxa*: which are not conservation dependent, but which are close to qualifying for vulnerable (see above criteria)
 - *Least concern*: these taxa are neither conservation dependent nor near threatened.

In Thailand, the following ranking system for threat levels has been presented:

- 5 Threatened at species level
- 4 Highly threatened at ecotype level (at risk of extinction in one major occurrence in near future, < 10 years)
- 3 Threatened at ecotype level (at risk of extinction in one major occurrence in next 10–30 years)
- 2 Threats to several populations, but slight or no risk of extinction in any major occurrence in foreseeable future
- 1 Minor threat to some populations
- 0 No known threat to any population
- n.a. Unknown/not sure

Economic importance or value of the priority species

The species with the following socioeconomic importance and use are to be listed as priority species (FORGENMAP 2000):

1. Timber production
2. Posts, poles and roundwood
3. Pulp and paper
4. Fuelwood and charcoal
5. Non-wood products (gums, resins, oils, tannins, medicines, dyes, etc.)
6. Food
7. Fodder
8. Shade and shelter
9. Agroforestry systems
10. Soil and water conservation
11. Amenity, aesthetic and ethical values
12. Others

Priority species for FGR conservation and management in Thailand

Detailed information on the socioeconomic importance, genetic variation and endangeredness is only available for a few Thai tree species. Accordingly, a different approach needs to be adopted for prioritising tree species for conservation action. The steps for identifying and clarifying priority species for the existing conservation programmes have been as follows:

1. A preliminary listing and ranking of important indigenous species was developed. This listing and ranking was based on the inclusion of the species in the previous RFD programmes, such as the Seed Management programme, Gene Bank programme; identification as priority species for planting, i.e. economic plantation species, and species identified for conservation in the 1998 FORGENMAP/RFD workshops. This list includes 89 species.
2. Review and refinement of this list was done by a working group of Thai forest experts at Kasetsart University (on 8/5/2000). Priority tree species for conservation were mainly identified on the basis of perceived threat, and to lesser extent on the level of within-species variation, as there was limited information on the subject. Appendix 2 shows a list of priority species for Thailand, conservation activities and recommended actions for genetic conservation.

Institutional framework

Major governmental bodies: their function and policies in conservation

The Ninth National Economic and Social Development Plan

Thailand had extravagantly exploited its abundant natural resources, without proper management, for national development process during the last four decades. Rehabilitation of natural resources and the environment was unable to keep pace with the problems of rapid degradation (NESDB 2002).

The 9th Plan emphasizes improvements in management practices to restore the equilibrium in the utilization and conservation of natural resources and the environment. It will promote the sustainable use of natural resources in order to support national economic development, enhance self-reliance, upgrade the quality of life of the Thai people and enhance the resilience of communities and the country. Thus, sustainable resource use will be the basis of future national development. Popular participation by all social sectors in the management of natural resources and environmental conservation will be encouraged (NESDB 2002).

Objectives of the 9th Plan put emphasis on restoring the proper balance in the use, preservation, and rehabilitation of natural resources. Effective control mechanisms over resource use shall be instituted. The Plan targets to reform the management of natural resources and increase participation of local people in the management and monitoring of environmental protection. According to the plan, forest reserves shall cover an area of not less than 25 percent of the whole Kingdom while the mangrove forest shall cover an area not less than 1.25 million rai (200 000 ha). A holistic management approach towards the rehabilitation of coastal environments as well as forest areas will be adopted.

The Royal Forest Department (RFD)

Since the designation of Khao Yai as Thailand's first national park in 1962, the conservation area has expanded to include 341 protected areas including 15 botanical gardens and 54 arboreta, covering more than 90 563km², or about 17.57% of the country's land area (see Table 2 for details). More parks and sanctuaries are being proposed for incorporation into the system.

The RFD was reorganized and restructured by the Government Body Restructuring Act 2002. The original Department has been split into three parts, i.e. the Royal Forest Department, the National Park, Wildlife and Plant Conservation Department, and the

Marine and Coastal Resources Department. However, policies related to forestry are still unchanged.

In the period of the 5th National Economic and Social Development Plan, The Cabinet approved the National Forest Policy drafted by of the National Forest Policy Committee on December 3, 1985. It comprises in total 20 broad key statements. Some of the important statements relevant to and used as the guidelines for actions in the management and conservation of forest resources are as follows:

- Thailand intends to have at least 40% of the country land surface to be covered by forests. Out of this percentage, 25% shall be designated as 'economic' forest, and 15% as 'conservation' forest. (Economic forests are used primarily for timber production and other non-wood forest products. Conservation forests in Thailand are equivalent to protected areas as defined by the IUCN. For instance, National Parks fall under the IUCN protected area Category II, Wildlife Sanctuaries under Category I, etc).
- All public sector and stakeholders including local people and ethnic minorities are collectively responsible for the protection, management and use of forestland and its resources.
- Land use zoning suitable for the country would be a principal tool for FGR conservation
- Provide conservation education and environmental awareness to the general public through media and other logical means.

In order to achieve the policy goals and objectives, forestry programmes and projects must be devised accordingly and updated periodically. These programmes and projects shall be integrated into the country's National Economic and Social Development Plan for implementation and subject for evaluation and revision.

The policy statements mentioned above have thus far provided a framework for the conservation actions focusing on forestland and its natural resources. For example, the RFD, a major implementing agency, has drawn up a national forest land-use plan comprising the economic forest zone and the conservation forest zone. The RFD had expanded its conservation forest or protected area system to fulfil the national policy by designating more forest areas during the past two decades. Currently, the percentage of conservation forest is well over the number prescribed in the policy. In addition, public participation in the conservation of forest resources has been addressed in a number of newly enacted laws including the new national constitution. Several forestry programmes related to forest resources conservation have been devised and integrated into the National Economic and Social Development Plant since 1987 or the 6th Plan onward.

In response to the 1985 National Forest Policy which required the long-term management and development plans to maximize the social, economic and environmental benefits of the forest, the Thai Forestry Sector Master Plan (TFSMP) was drafted with funding supported by the Finnish International Development Agency (FINNIDA) in 1993. The TFSMP guides long-term development in the forestry sector, taking into consideration socio-ecological, technological and institutional aspects. Conservation of forest resources and biodiversity guidelines proposed in the Master Plan are under the people and forestry environment programme. The programme concerns the conservation of representative ecosystems and diverse biological resources in protected areas, as well as conservation of biological resources outside the protected areas.

The Office of Environmental Policy and Planning (OEPP)

The Office of Environmental Policy and Planning (OEPP) is the key centre and leader of the coordination in natural resources and environmental administration and management of the country in order to encourage national sustainable development. Economic utilization of the environment must be based on conservation, social equity and better quality of life of people. At the same time it encourages the efficiency of integrated system for

environmental quality administration and management by administrative and management decentralization from central Government to local authority. It also builds up public awareness and encourages the public to participate in environmental quality prevention, remedy and rehabilitation. The OEPP also acts as the regional leader in environmental management and implementation of the policy according to the environmental obligations with foreign countries. According to its roles the OEPP has three Sectors: Environmental Policy and Planning Sector, Environmental Quality Management Sector and Regional Environmental Management Sector.

The policies related to conservation of forest resources include the Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality (1997–2016), policy on natural resources, policy on natural and cultural environments, policy on environmental education and promotion. There are three Divisions under the Environmental Policy and Planning Sector.

Specifically, the Environment Quality Management Sector handles the biological resources management tasks through the Division of Natural Resources and Environmental Management and Coordination. In accordance with the framework of the CBD, through this division the OEPP compiled and formulated the Biological Diversity Report of Thailand. Furthermore, it also formulated the National Policy, Measures and Plans on the Conservation and Sustainable Biological Diversity (1998–2002), which was approved by the Cabinet in 1997 and has become a Principle framework for biodiversity conservation and management in Thailand. The Regulation on Biological Diversity Utilization and Conservation, also approved by the Cabinet in 1997, aimed at creating coordination among agencies to get access to the biological resources and the negotiation for the benefit that Thailand should receive from the utilization of national biological resources with justice and equity.

The OEPP under the supervision of the Steering Committee on Implementation of National Action Plan for Sustainable Development (Agenda 21) has formulated the Policy and National Action Plan for Sustainable Development of Thailand. It is proposed that Thailand's forest cover shall be increased to 50% of its land surface. At least 30% is to be designated as conservation forest, and 20% as economic forest, to ensure that the demands of economic and social development are met, and to maintain the environmental balance. The policy calls for efforts to protect, preserve and conserve flora, fauna, aquatic life, and other living organisms in forestlands.

Policy and Prospective Plan for Enhancement and Conservation of National Environment Quality (1997–2016) has two main aspects: policy on natural resources and policy on pollution. Under the policy on natural resources, it has been proposed to increase efficiency in the use of natural resources; enhance administration and management of natural resources by systematic decentralization of power; support the application of resource economics for effective management of natural resources; amend the legal and regulatory framework enabling support for more effective administration and management of natural resources and recognition of rights and responsibilities of local people to demonstrate ownership of resources. It further proposed to support the study, research, and establishment of a standardized database network for natural resources and to increase conservation awareness of senior Government officers, politicians at all levels, private sector, and general public, in order to integrate concepts for natural resources development and conservation, ensuring their movement in the same direction (OEPP 1997).

Thailand has not ratified the Convention on Biological Diversity (CBD), although the Cabinet approved CBD ratification in 1997. However, implementing many activities advocated in the Convention has been progressing. Formulation of the National Policy, Measures, and Plans on the Conservation and Sustainable Biological Diversity was approved by the Cabinet on July 15, 1997. This policy proposed several new and additional initiatives to existing relevant institutions in order to support the protection of biodiversity of the country. The main focus of the national strategy was directed towards emphasizing and enhancing present responsibilities of the implementing institutions. The strategies on the conservation and utilization of biological diversity are prioritised into seven strategies.

These are:

Strategy 1 – Building the capacity of institutions and their staff on the conservation of biodiversity.
Strategy 2 – Enhance efficiency in management of protected areas to ensure sustainable protection of overall biodiversity at local level.

Strategy 3 – Improve incentives for conservation of species, population and ecosystems.

Strategy 4 – Conservation of species, populations, ecosystems.

Strategy 5 – Control and monitor processes and activities that threaten existence and richness of biodiversity.

Strategy 6 – Encourage the management of biodiversity in the environment and traditional culture.

Strategy 7 – Promote cooperation between international and national agencies/ institutions in conservation and sustainable utilization of biodiversity.

The measures for *in situ* conservation of biodiversity are emphasized in Objectives 4.1 of the Strategy 4 (*Improve capacity in the conservation of species, population and genetic diversity in natural habitats*) Objectives 2.1 (*To ensure that the protected areas are capable to conserve rare and endangered species and ecosystems*), 2.3 (*To increase capacity in protected areas management*) and 2.4 (*To improve the conservation of protected areas*) also focus on *in situ* conservation. In addition, several measures from the remaining strategies are supportive to conservation *in situ* of biological diversity.

The measures related to *ex situ* conservation of biodiversity are found in Objective 4.2 (*Improve capacity of the ex situ conservation to enable biodiversity conservation, promote public education and support sustainable development*) of the Strategy 4. In addition, several measures mentioned under *in situ* conservation provide support to *ex situ* conservation.

Department of Environment Quality Promotion (DEQP)

In 1992, according to the revision of the Enhancement and Conservation of National Environmental Quality Act, the Office of the National Environmental Board was replaced by three new environmental Departments: the Office of Environmental Policy and Planning (OEPP), the Pollution Control Department (PCD) and the Department of Environmental Quality Promotion (DEQP) (DEQP 1994). This governmental body relates to forest resources conservation in terms of promoting and building public awareness as well as increasing public education in conservation of forest resources.

The National Science and Technology Development Agency (NSTDA)

The National Science and Technology Development Agency (NSTDA) is a funding and research organization established under the Science and Technology Development Act, of B.E. 2534 (1991) on December 30, 1991. The NSTDA is an autonomous organization operating under policy guidance of its own board, chaired by the Minister of Science, Technology and Environment. The NSTDA operates outside the normal framework of state-enterprise and civil service. The agency has adopted a broad and systematic approach towards enhancing the entire Science and Technology sector in support of national economic and social development.

NSTDA's target is to improve production and service, as well as backing research aimed at commercial application. Three specialized centres; Genetic Engineering and Biotechnology (BIOTEC), Metal and Materials Technology as well as Electronics and Computer Technology come under the NSTDA umbrella. In addition, its Technology Information Access Centre provides on-line information services from important databases worldwide. The NSTDA maintains close associations with public and private research institutions and works together to organize training courses and technical seminars for human resource and institutional commercialisation, as well as for promoting public welfare.

Genetic Engineering and Biotechnology Centre (BIOTEC)

The Genetic Engineering and Biotechnology Centre (BIOTEC), originally known as NCGB, was first set up under the Ministry for Science, Technology and Energy on 20 September 1983. After the establishment of the NSTDA in 1991, BIOTEC became one of the NSTDA centres, operating autonomously outside the normal framework of civil service and state enterprises. The main objectives of BIOTEC are to induce dynamics in research, development and application of biotechnology in order to support technology development and adoption in both public and private institutions. Activities are not limited to high technology, but also focus on medium and basic level technology, particularly when used for building up the country's skill resource, or adapting technology appropriate for Thailand's development.

The Biodiversity Research and Training Programme (BRT) is a special programme established under BIOTEC to provide support and funding for research into and management of Thailand's biodiversity resources. The BRT Programme addresses the need for research and training to assess the biodiversity remaining in the Kingdom and to investigate the present and potential benefits of biodiversity for human life. Some examples of research projects supported by BRT include: Study of plant diversity in Phu Phan National Park; Biodiversity of plants at Ton Nga Chang, Southern Thailand; Plant diversity at Khun Korn Waterfall Forest Park, Chiengrai; Evaluating the status of genetic resources of *Tectona grandis* using molecular markers and Cytogenetic study of Euphorbiaceae in Thailand.

Thailand Biodiversity Centre is also a new special program under BIOTEC established in January 2000 as a result of the Prime Minister decree on biodiversity conservation and utilization. The centre collaborates with other organizations in order to manage biodiversity of Thailand and expands collaboration around the world. Its main functions are to serve as a data base centre and disseminate information related to biodiversity conservation to researchers and public in general as well as to raise public awareness and public participation on biodiversity conservation through workshops and publications.

Institutional issues

Several institutional restructuring schemes affecting forest conservation have been proposed. Finally according to the Government Body Restructuring Act 2002, national parks, wildlife conservation and watershed conservation are under the National Park, Wildlife and Plant Conservation Department, Ministry of Natural Resources and Environment. However, the Office of Environmental Planning and Policy, the Department of Environmental Quality Promotion and the Department of Marine and Coastal Resources are under the same Ministry. The Royal Forest Department is in the process of transferring to the Ministry of Natural Resources and Environment.

National acts, regulations and resolutions dealing with conservation

The relevant Forest and Environmental Acts and other regulations and resolutions related to forest conservation are as follows:

Forestry Act B.E.2484 (1941)

This Act regulates operation and non-wood forest product collection.

National Park Act B.E. 2504 (1961)

This Act prescribes the determination of National Park land, protection and maintenance of National Parks and penalties.

National Reserved Forest Act B.E. 2507 (1964)

This Act prescribes the determination of National Reserved Forest, control over and maintenance of the National Reserved Forest, penalties and transitory provisions.

Wildlife Preservation and Protection Act B.E. 2535 (1992)

This Act prescribes chapters including: appointment, roles and responsibilities of the National Wildlife Preservation and Protection Committee; hunting, propagating, possessing and trading in the wildlife, their carcasses and carcass products; importing, exporting, passing through, moving the wildlife and wild life check point; a public zoo; area and place under prohibition of wildlife hunting; the competent officer; penalties.

Enhancement and Conservation of National Environment Quality Act B.E.2535 (1992)

This is Act gives directives on appointment and responsibilities of National Environmental Board; Environmental fund; Environmental protection; Pollution control; Promotional measures, Civil liability, and Penal provisions.

Sub-District Administration Act 2537 (1994)

Determine roles and responsibilities of Sub-district organization (Or-Bor-Tor) including natural resources and environmental management. Under section 67, Or Bor Tor has to protect, and rehabilitate natural resources and environment in their areas.

Ministry Resolution: Watershed Classification 2528, 2529 (1985, 1986)

Regarding land-use practices in the watershed area, the Government also developed a set of resource utilization and management practices for each operating unit within each major watershed class (WSC).

Community Forest Act

In addition to all above, a Community Forest Act is now being drafted under consideration of the Cabinet a) to act as a tool in environmental protection and development, b) to provide a framework for utilizing natural resources sustainably in order to protect the forest ecosystem, c) to underline and support the roles of communities that protect, use and develop forests their traditional ways and d) to promote cooperative processes between the State and communities. There are conflicting ideas regarding the issue of the location of community forests. Agreement has not yet been reached on whether areas within protected areas can be used as community forests. Thus, the Community Forest Act is still pending for final agreement.

Proposal for regional and international collaboration

The growing concern over the long-term sustainability of forest ecosystems, species and genetic resources has led to the development of national policies and plans in many countries. However, most programmes have been confined to national boundaries and, thus have faced limitations. Many tree species have regional or global ranges while a good number of introduced species may have developed into well-adapted land races and become economically important outside their original ranges. Therefore, conservation as well as improvement programmes may be a common interest to several countries. To create collaboration in the use of the limited FGR as well as to avoid overlapping and duplication of efforts, it is essential to establish some kind of link or network at regional and global levels. As an example, Thailand initiated a regional cooperation programme in 2000, seeking financial support from an international organization.

The project "Management of the Phatam Protected Forest Complex to Promote Cooperation for Trans-boundary Biodiversity Conservation between Thailand, Cambodia and Laos" aims at strengthening the management planning for the Phatam Protected Forest Complex and to develop strategies for trans-boundary biodiversity conservation. This project was proposed by Thailand. The Project life is two years, being executed through a joint committee and receiving major financial support from the ITTO. The Project terminated at the end of September 2003 resulting in a plan and strategy for biodiversity conservation for the three countries.

Regional as well as international collaboration in FGR conservation may be established in the form of networking. Some active networks in the region at present include, for example, International Neem Network, the International Network on Bamboo and Rattan (INBAR) and TEAKNET. These networks can be used as models for the proposed Asia-Pacific Forest Genetic Resources Programme. However, many important issues have to be discussed and clarified. They include, for example:

1. Common species identification and/or priority species
2. Standard methodology for conservation (*in situ*, *ex situ* or other)
3. Access to genetic resources and exchange of tree germplasm
4. Material transfer agreement
5. Research coordination and dissemination of research results
6. Information exchange
7. Benefit sharing in case of commercial uses/development of FGR of partner countries
8. Intellectual property rights
9. Financial support for the sustainability of the network, etc.

The above undertakings may take a long time. However, it is beneficial for member countries to play a regional as well as international role because economically valuable goods and products, including many environmental services may be derived from the FGR of the region.

Conclusion

Country priorities

Rapid depletion of the natural forests in Thailand is a root cause of serious problems in the country's environment and economy. The logging ban was imposed to remedy the situation, and a Master Plan for reforestation was also introduced. The Plan aims at bringing back the forest cover to 40% of the nation's land area within the next 40 years. It is foreseeable that this target can be reached through improved protection of the remaining natural forests and increased plantation forestry measures. Proper FGR conservation and management will play a vital role in plantation activities.

Thailand has obtained substantial amount of know-how in forest tree improvement of some economically important species during the past 35 years with the assistance of the Royal Danish Government. The genetic resources of many species have been conserved and developed (e.g. teak, pines and some hardwood species). It is anticipated that future planting programmes, both public and private, will use a greater diversity of species including both indigenous and exotic ones. Conservation of genetic resources of individual priority species has to be expanded for future usage in producing high quality planting materials.

Thailand has identified priority species as listed in Appendix 2. However, due to the great diversity of vegetation, more species may be included to the list later.

Research needs

It is important that detailed information of individual tree species will be available for decision-making. The following research needs can be identified:

- Research on taxonomy
- Research on the importance of species for maintaining ecosystem functions and services, such as watershed protection
- Research on the level of within-species variation
- Research on the level of threat or risk of extinction of species
- Research on the use of genetic markers in conservation
- Research on participatory systems on conservation or partnership conservation
- Research and/or collation of information on biological and demographical characteristics, etc.

Needs for international collaboration

Though efforts and resources have been put into many programmes in Thailand, some constraints are still limiting the advancement of many programmes. It is evident that more achievements can be obtained if outside assistance and international collaboration are available. Therefore, Thailand needs international collaboration in the field of FGR conservation and management.

References

- Anon. 2002. Progress Report. *In situ* Forest Genetic Resources Conservation in Thailand [in Thai]. Silviculture Research Division, Royal Forest Department. Unpublished. 26 pp.
- Boontawee, B., C. Plengkai and A. Kao-sa-ard. 1995. Monitoring and measuring forest biodiversity in Thailand. *In* Measuring and monitoring biodiversity in tropical and temperate forests: proceedings of a IUFRO Symposium held at Chiang Mai, Thailand. August 27th – September 2nd, 1994 (T.J.B. Boyle and B. Boontawee, eds.). CIFOR, Bogor, Indonesia. 395 pp.
- DEQP (Department of Environmental Quality Promotion). 1994. Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992). Ministry of Science, Technology and Environment. Translated by the Environmental Law Centre. 32 pp.
- DFSC. 1997. Preliminary assessment report of the evaluation of the FAO coordinated *Ex situ* Forest Genetic Resources Conservation Programme. Danida Forest Seed Centre, Humlebaek, Denmark. 89 pp.
- DFSC. 2000. Conservation of genetic resources of *Pinus merkusii* in Thailand. DFSC Series of Technical Notes. TN 56. Danida Forest Seed Centre, Humlebaek, Denmark. 35pp.
- FORGENMAP (Forest Genetic Resources Conservation and Management Programme). 2000. Workshop Report No.7. Identification of Priority Species for Biodiversity and Tree Planting. 1998. Royal Forest Department, Bangkok. 72 pp.
- FORGENMAP (Forest Genetic Resources Conservation and Management Programme). 2002. Consultancy Report 20. Conservation Strategy for Forest Genetic Resources of Thailand. Prepared by FORGENMAP, the Royal Forest Department, Danced and DFSC. 110 pp.
- NESDB (National Economic and Social Development Board). 2002. The Ninth Economic and Social Development Plan (2002–2006). Office of the Prime Minister, Bangkok, Thailand. 114 pp.
- OEPP (Office of Environmental Policy and Planning). 1997. Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality, 1997-2016. Ministry of Science, Technology and Environment, Bangkok, Thailand. 92 pp.
- Piyaphan, P. 1999. Teak Improvement Programme in Thailand [in Thai]. Technical Paper, Silviculture Research Division, Royal Forest Department. 151 pp.
- Ratanawatkul, K. 2001. Pine Improvement in Thailand [in Thai]. Technical Paper. Silviculture Research Division, Royal Forest Department. 151 pp.
- RFD (Royal Forest Department). 1993. Thai Forestry Sector Master Plan Volumes 5 and 6. Ministry of Agriculture and Cooperatives, Bangkok. 192 pp.
- RFD (Royal Forest Department). 1996. Hundred-year of Forestry Research in Thailand [in Thai]. Royal Forest Department, Bangkok. 264 pp.
- RFD (Royal Forest Department). 1999. Forestry Statistics of Thailand. Royal Forest Department, Bangkok. 153 pp.
- RFD (Royal Forest Department). 2001. Forestry Statistics of Thailand. Royal Forest Department, Bangkok. 156 pp.
- Smitinand, T. 1989. Thailand. Pp. 63-82 *in* Floristic Inventory of Tropical Countries: Status of Plant Systematics, Collections and Vegetation, plus Recommendations for the Future (D. G. Campbell and H. D. Hammond, eds.). New York Botanical Garden, New York.
- Sumantakul, V. 2001. Thai-Danish Technical Cooperation in Forestry: Past – Present – Future. A paper presented at a symposium on “A Centenary Celebration of Thai-Danish Cooperation in Biodiversity”. Queen Sirikit Botanic Garden, Chiang Mai, Thailand. 10–11 February 2001. 8 pp.
- Sutthisrisinn, C. and Noochdumrong, A. 1998. Country Report: Thailand Forestry Policy and Planning. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. 62 pp.

Appendix 1

Details of ex situ conservation stands for exotic species in Thailand (DFSC 1997)

Site	Species	Provenance	Seed lot	Year of establishment	Area (ha)	
Nong Krating Seed Production Station, Om Koi district, Chiang Mai	<i>Pinus caribaea</i>	La Brea Colon	S2043	1979	n.a.	
		La Mosquito	S2046	1979	n.a.	
		Culmi	S2280	1981	n.a.	
		Poptun	S2045	1979	n.a.	
		Lololo Island	S2047	1981	n.a.	
		Poptun	S2045	1981	n.a.	
	<i>P. oocarpa</i>	Culmi	S2276	1982	n.a.	
		Jocotan	S3130	1979	n.a.	
		Mal Paso	S3129	1979	n.a.	
Ubon Ratchathani Gene Cons. Station, Khong Chiam district, Ubon Ratchathani	<i>P. caribaea</i>	Alamicamba	PIC 2278/ DFSC/1033/82	1985	n.a.	
Tatoom Experimental Station, Tatoom district, Surin	<i>Eucalyptus camaldulensis</i>	Gibb River	PIC S4040 CSIRO 10558	1977	n.a.	
		Petford	PIC S4039 CSIRO 10911	a) 1978 b) 1980	n.a. n.a.	
		Gibb River	PIC S4040 CSIRO 10558	1980	n.a.	
Huay Bong Experimental Station, Hod district, Chiang Mai	<i>E. camaldulensis</i>	Gibb River	CSIRO 10558	1978	n.a.	
		Petford	PIC S4039 CSIRO 10911	1977	4.4	
		Gibb River	CSIRO 10558	1997	5.5	
		Petford	CSIRO 12186	1979	n.a.	
		<i>P. oocarpa</i>	Yucul	PIC 3119 OFI 2/76	1978	n.a.
			Mt. Pine Ridge	PIC 3118 OFI 10174	1977	4.8
	Mal Paso		S 3129	1979	6.8	
	Dipilto		S 3073	1975	n.a.	
	Lagunilla		S 3092	1981	11.8	
	Yucul		PIC 3119 OFI 2/76	1977	5.9	
	San Rafael		PIC 3254 DFSC 1022/82	1984	5.9	
	Mt. Pine Ridge	PIC 3074	n.a.	n.a.		
	<i>P. caribaea</i>	Los Limones	PIC 2041 61a	1978	18	
Los Limones		PIC 2277	1984	n.a.		
La Mosquito		S 2046 71a	1979	21.3		
San Carlos		S 2044 35a	1979	n.a.		
Alamicamba		PIC 2033 OFI 6/74 FAO/UNEP21A	1975	n.a.		
Alamicamba		PIC 2278 DFSC 1033/82 21b	1986	5.5		

Site	Species	Provenance	Seed lot	Year of establishment	Area (ha)
		Culmi	S 2280 DFSC 1058/82 101+92 a	1985	8.8
		Alamicamba	PIC 2040 OFI 6/74 58	1977	5.3
		Los Limones	PIC 2041 OFI 24/75 56 a	1977	3.5
		Santa Clara	PIC 2279 DFSC 1049/82 107a+b	1984	8.8
		Los Limones	PIC 2277 106	1983	n.a.
Intakin Experimental Station, Mae Taeng district, Chiang Mai	<i>P. caribaea</i>	Poptun	DFSC 1134/83	1987	n.a.
Pine Improvement Station (Mae Sanaam), Hod district, Chiang Mai	<i>P. caribaea</i>	San Rafael	PIC 3254 DFSC 1022/82	1984	n.a.
		Alamicamba	S 2278 DFSC 1033/82	1984	n.a.
		Honduras	S 2028	1973	n.a.
Nong Khu Gene Conservation Station, Sang Kha district, Surin	<i>P. oocarpa</i>	Cuba	S 2030	1973	21
		Los Limones	S 2277	1983	n.a.
		Los Limones	PIC 2281 DFSC 1056/82	1989	n.a.
		Los Limones	PIC 2281 DFSC 1056/82	1988	n.a.
		Guatemala	S 3070	1973	n.a.
	<i>P. oocarpa</i>	Guatemala	S 3062	1973	n.a.
		Yucul	S 3256	1984	n.a.
		San Rafael	S 3254 DFSC 1021/82	1984	n.a.
		Mal Paso	PIC 3255 and PIC 3129, DFSC 5519	1987	n.a.
		Yucul	DFSC 1021/82 or OFI 2/76n.a.	1981	n.a.

n.a. = data not available

Appendix 2

Information on the priority species for Thailand

Priority level and species	Areas managed for conservation (ha)			Areas managed in natural forest for production (ha)		Areas managed in plantation for production (ha)		Recommend actions for genetic conservation	References and reports
	In situ	Ex situ	Seed production	Timber	Non-timber	Timber	Non-timber		
TOP PRIORITY									
<i>Azela xylocarpa</i>		40						Establish more ex situ conservation efforts	FORGENMAP 2002
<i>Dipterocarpus alatus</i>		72						Establ. more ex situ	FORGENMAP 2002
<i>Hopea odorata</i>		52						Establ. more ex situ	FORGENMAP 2002
<i>Pterocarpus macrocarpus</i>		36						Establ. more ex situ	FORGENMAP 2002
<i>Tectona grandis</i>		1894	1221					Strict protection	Unpublished report of TIP (2001)
VERY HIGH PRIORITY									
<i>Alstonia scholaris</i>								Establish ex situ	
<i>Aquilaria crassna</i>		56						Establish ex situ	FORGENMAP 2002
<i>Dalbergia cochinchinensis</i>		34						Establ. more ex situ	FORGENMAP 2002
<i>Dalbergia oliveri</i>								Establ. ex situ	
<i>Intsia palembanica</i>								Establ. ex situ	
<i>Mangifera</i> spp. (wild species)								Establ. ex situ	
<i>Millettia kangensis</i>								Establ. ex situ	
<i>Pinus merkusii</i>	1060	13	5.7					Establ. more ex situ	Unpublished report of PIP 2001
<i>Wrightia tomentosa</i>								Establ. ex situ	
<i>Xylocarpa</i> var. <i>kerrii</i>		50						Establ. more ex situ	FORGENMAP 2002

Priority level and species	Areas managed for conservation (ha)			Areas managed in natural forest for production (ha)		Areas managed in plantation for production (ha)		Recommend actions for genetic conservation	References and reports
	In situ	Ex situ	Seed production	Timber	Non-timber	Timber	Non-timber		
OTHER PRIORITY									
<i>Azadirachta excelsa</i>								Establ. ex situ	
<i>Chukrasia</i> spp.								Establ. ex situ	
<i>Cotylelobium melanoxylon</i>								Establ. ex situ	
<i>Dipterocarpus tuberculatus</i>								Establ. ex situ	
<i>Durio mansoni</i>								Establ. ex situ	
<i>Fagraea fragrans</i>								Establ. ex situ	
<i>Gmelina arborea</i>								Establ. ex situ	
<i>Holoptelea integrifolia</i>								Establ. ex situ	
<i>Hopea ferrea</i>								Establ. ex situ	
<i>Manglietia garrettii</i>								Establ. ex situ	
<i>Mansonia gagei</i>								Establ. ex situ	
<i>Azadirachta indica</i>								Establ. ex situ	
<i>Melientha suavis</i>								Establ. ex situ	
<i>Parashorea stellata</i>								Establ. ex situ	
<i>Parkia speciosa</i>								Establ. ex situ	
<i>Pinus kesiya</i>	233		42.8					Establ. more ex situ	Unpublished report of PIP 2001
<i>Shorea henryana</i>								Establ. ex situ	
<i>Shorea roxburghii</i>	36							Establ. more ex situ	FORGENMAP 2002
<i>Tetrameles nudiflora</i>								Establ. ex situ	
<i>Toona ciliata</i>								Establ. ex situ	