# *4. Development of the Forest Gene Conservation Strategy in Cambodia*

## 4.1 Background

A series of meetings was held with a range of stakeholders. The preliminary meetings agreed on the importance of the formulation of a forest gene conservation strategy. It was decided that the strategy should be developed in collaboration between stakeholders to better reflect the national development goals in relation to biodiversity, environmental, and socio-economic issues.

**The first meeting on the Forest Gene Conservation Strategy was held in September 2001. It established a multi-disciplinary working group to develop the strategy, and identified future steps for action.**

All members of the Working Group are officially appointed by RGC. The members of, and Terms of Reference for, the Working Group are found in Appendix 1, and include representatives from :

- MAFF Forestry Administration/Cambodia Tree Seed Project (6)
- Ministry of Health (1)
- Ministry of Environment (2)
- Royal University of Phnom Penh (2)
- Royal University of Agriculture (1)
- IUCN (1)
- WWF (1)
- Concern Worldwide (1)
- Danida Forest Seed Centre, as consultant to ITSP (1)

The Working Group has officially met three times, and a number of sub-meetings with some members were held during 2001 - 2003. The Working Group developed the following:

- monographs for the priority species (Annex 1)
- digitised species distribution maps (Annex 1)
- distribution and conservation status of priority tree species for gene conservation in Cambodia (Annex 2)
- action plan for the conservation of selected forest genetic resources (Table 5)

The comprehensive documentation provided by the Working Group forms the foundation for the Forest Gene Conservation Strategy. The methodological approach developed by the Working Group should be followed during strategy implementation.

## 4.2 Selection of Priority Species

### *4.2.1 Species Selection*

The first step towards forest tree gene conservation was the identification and prioritisation of species, around the main criteria of socio-economic importance, and the level of threat or risk (FORGENMAP, 2002).

- *Socio-Economic Importance* is assessed by the commercial value of the species, the extent to which it is in demand for planting, and its role in maintaining ecosystem functions and services.
- *Level of Threat or Risk* is based on IUCN categories for critically endangered, endangered, vulnerable, or lower risk species, combined with the judgements of the Working Group based on their in-depth local knowledge.

The Working Group was provided with information on indigenous species, including distribution, biological characteristics, and conservation status. Members completed a questionnaire to assess the degree of threat to different species from fire, logging, land clearance, overgrazing, and infrastructure development. Through this exercise, the participants were prepared to enter into discussions on species selection. Species were ranked according to their potential uses as timber, posts and poles, fuelwood and charcoal, NTFPs, pulp and paper, food, shade, agro-forestry systems, soil and water conservation, aesthetic and ethical values, or other. This resulted in a list of 34 priority species.

Each of the identified species were further classified according to the IUCN Red List Categories, from critically endangered (level 5) to endangered (level 4) and threatened (levels 1 – 3). Where IUCN data was not available the classification was based on local knowledge using IUCN criteria. The Working Group recommended to allocate priority status to the two most threatened categories, "critically endangered" and "endangered", resulting in an initial list of 21 priority species for forest gene conservation in Cambodia (Table 1). Species numbered 22 – 34 will receive less attention given their lower priority, and the limited resources for implementation. However, the methodological approach developed by the working group may also be applied for other tree species deemed of local or regional importance.

**Based on available information, potential uses, and IUCN conservation criteria, 34 indigenous species were classified as endangered or threatened. The 21 endangered species were allocated priority status for forest gene conservation.**

Table 1 – Priority Tree Species for Gene Conservation

| Nº | Scientific Name | Assessed Level of Threat | IUCN Red List |
|---|---|---|---|
| 1 | *Dalbergia oliveri* | 5 | EN A1cd |
| 2 | *Aquilaria crassna* Pierre | 5 | CR A1cd |
| 3 | *Dalbergia cochinchinensis* Pierre | 5 | VU A1cd |
| 4 | *Gardenia ankorensis* Pit | 5 | |
| 5 | *Afzelia xylocarpa* (Kruz.) Craib | 5 | EN A1cd |
| 6 | *Pterocarpus macrocarpus* Kurz. | 5 | VU A1d |
| 7 | *Dysoxylum loureiri* Pierre | 5 | |
| 8 | *Diospyros cruenata* Thwaites | 5 | |
| 9 | *Lasianthus kamputensis* Pierre ex. Pit | 5 | |
| 10 | *Diospyros bejaudii* Lecomte | 4 | |
| 11 | *Fagraea fragrans* Pit | 4 | |
| 12 | *Dasymaschalon lamentaceum* Finet et Gagnep | 4 | |
| 13 | *Shorea cochinchinensis* Pierre | 4 | |
| 14 | *Hopea helferi* (Dyer) Brandis | 4 | CR A1cd + 2cd, B1 + 2c |
| 15 | *Pinus merkusii* Jungh et de Vries | 4 | |
| 16 | *Garcinia hanburyi* Hook.f. | 4 | |
| 17 | *Cinnamomum cambodianum* Lecomte | 4 | |
| 18 | *Sterculia lychnophora* Hance | 4 | |
| 19 | *Cananga latifolia* (Hook.f .& Thomson) Finet & Gagnep | 4 | |
| 20 | *Albizia lebbek* (L.) Benth. | 4 | |
| 21 | *Hopea odorata* Roxb. | 4 | VU A1cd + 2cd |
| 22 | *Tarrietia javanica* Blume | 3 | |
| 23 | *Diospyros pilosanthera* Blanco | 3 | NE |
| 24 | *Hopea ferrea* Laness | 3 | EN A1cd + 2cd, B1 + 2c |
| 25 | *Xylia dolabriformis* Benth | 3 | |
| 26 | *Fibraurea tinctoria* Lour | 3 | |
| 27 | *Shorea hypochra* Hance | 3 | CR A1cd |
| 28 | *Shorea vulgaris* Pierre | 3 | |
| 29 | *Diospyros nitida* Merr | 3 | |
| 30 | *Cassia garretiana* Craib | 2 | |
| 31 | *Dipterocarpus alatus* Roxb. ex G. Don | 2 | EN A1cd + 2cd, B1 + 2c |
| 32 | *Anisoptera costata* Kort | 2 | EN A1cd + 2cd |
| 33 | *Melanorrhoea laccifera* Pierre | 2 | |
| 34 | *Artocarpus chaphasha* Roxb | 1 | |

### *4.2.2 Species Monographs*

Information on the distribution, biology and status of a species is essential to define effective conservation measures. A paper on the Flora of Cambodia provides a background to botanical work undertaken in Cambodia, and also highlights gaps in current knowledge of species. It is located in Annex 1, along with monographs for each of the 21 priority species, and digitalized distribution maps. The documentation was compiled following a comprehensive literature search and consists of available information on:

- distribution and habitat
- Ecological zonation
- botanical description
- flowering and fruiting habit
- fruit and seed description
- seed handling
- sowing and germination
- current situation including conservation status based on local information
- uses
- IUCN classification

**Information on Cambodian tree species is limited. Available documentation has been compiled into monographs for each of the 21 priority species.**

## 4.3 Assessment of Species Distribution and Overall Conservation Status

The assessment of species distribution and conservation status is presented in Annex 2. Information on the distribution and status of the 21 priority species was discussed within a panel of experts, including people with extensive forest inventory experience. The discussions led to the development of distribution maps for each species within forest concessions, which found that some species have limited distribution. The maps were digitised by the GIS and RS Unit of FA, and presented in Annex 1.

The documentation on Cambodian tree species distribution and status is the most comprehensive to date, and provides much new information. However, data on many tree species remains limited, and further botanical surveys and inventories were recommended, to better assess the distribution and status of priority tree species.

**Many tree species have been, and are continuing to be, overexploited at several locations, leading to genetic degradation.**

## 4.4 Assessment of Genetic Variation within Species

There is a range of techniques to assess genetic variation within species. Such assessment is necessary to establish an effective network of conservation stands representing populations of different genetic composition. Whilst field trials provide the most robust method of assessing genetic variation, they require long periods of growth at many sites. Genetic markers have more

recently enabled faster surveys but fail to detect adaptive genetic attributes. Gene-ecological zonation is a cost effective method for assessment of genetic variation.

### *4.4.1 Gene-ecological Zonation*

Gene-ecological zonation is a simple, low cost method to assess genetic variation based on available data. Therefore, the principles of gene-ecological zonation are recommended for forest gene conservation in Cambodia.

If local adaptation through natural selection is accepted as the main factor introducing genetic variation within species, then similarities of ecological conditions can be assumed to imply similarities of genetic constitution.

**A gene-ecological zone is an area with sufficiently uniform ecological conditions to assume similar genetic characters within a species (Graudal *et al.*, 1997).**

Gene-ecological zones should be defined as large enough to mitigate the results of pollen flow between zones, and small enough to assume genetic similarities between populations within a given zone, and is subject to pragmatic judgement. Typically, parameters for zonation are natural vegetation, topography, climate, soil, and barriers to gene flow. An indication of genetic variation within species can be gained by comparing species distribution with well-defined ecological zones.

**In Cambodia, seven distinct ecological zones have been identified on the basis of bio-climate, vegetation, physiography, and soil.**

## 4.5 Assessment of Conservation Status within Gene-Ecological Zones

An assessment of conservation status requires an analysis of the present state of the genetic resource and future threats. Factors include:

- change of environment (climate)
- extinction of associated species
- introduction of competitive species
- over-logging or encroachment
- conversion of forest land to agriculture, roads, towns, etc
- indirect human activities, such as drainage, dams or fire
- fragmentation of populations causing inbreeding depression

**Forests within Cambodia are under threat from encroachment, logging, land conversion, and other human activities. The genetic resources of priority species identified for conservation are subject to dramatic genetic erosion.**

The conservation status of a species and its populations can be assessed based on the following (Graudal *et al*., 1997):

- *Past and Present Geographical Distribution*
  The major threat to a reduction in the area of distribution of species is land use change, which can provide an initial indication of areas in need of special attention. The lack of forestry inventory within Cambodia restricts this type of identification, although the digitised distribution maps shown in Annex 1 highlight the current distribution of priority species within forest concession areas, and at provincial level.
- *Prevailing Utilisation Patterns*
  Forest genetic resources could become eroded depending on the utilisation of its habitat. The tree stands identified in Annex 1 are mostly located in forest concession areas, and therefore, may have been affected by selective logging operations, through which the best trees have already been logged.
- *Possible Occurrence in Protected Areas*
  In Cambodia, a large percentage (18%) of the country is under protected area management, which may contribute to forest genetic resource conservation, and function as important repositories for gene conservation populations.

## 4.6 Identification of Key Populations and their Conservation Status

The number of stands to be conserved and their geographical distribution are identified through a comparison of genecological zones with the species conservation status. The identification process may follow the principles below (Graudal *et al.* 1997).

1. overlay the genecological zones with:
   - past and present geographical distribution of the species
   - occurrence of the species in ongoing planting programmes and protected areas
   - location of provenances/populations of proven value

2. consider factors affecting genetic variation, conservation status, and the conservation investment requirements
   - type of distribution area
   - reproduction and dispersal biology
   - differences between past and present distribution
   - size and geographical location of past and ongoing planting programmes, and origin of the planting material used
   - possible effects of selective logging/felling in each zone
   - occurrence of populations in protected areas
   - degree of threats
   - land tenure and associated options and costs

3. decide on appropriate geographical distribution and number of areas per zone to be sampled for conservation of genetic resources of selected species.

### *4.6.1 Number of Populations*

The number of populations selected for conservation in each zone should generally be higher for outbreeding species with scattered distribution, insect pollination, and limited seed dispersal,

assuming larger genetic variation between populations than for species with continuous distribution, wind pollination and wide seed dispersal. Factors to consider in stand selection include (Graudal *et al*., 2001):

- abundance of target species and presence of key associated species
- low level of risk/threats (including secure land tenure)
- committed and adequately staffed management agency
- support from local people, owners and users of the area
- compact shape of area and presence of forest buffer zone
- possible opportunities to conserve other priority species
- minimum of 2 stands in each genecological zone (FORGENMAP, 2002)

### *4.6.2 Size of Conservation Stands*

The size of conservation stands inevitably varies, but small populations are more liable to inbreeding and genetic erosion. A number of 500 is often recommended for conservation purposes. Given a population size of 500 – 1,500, the area requirements could be in the range of 5 – 10,000 hectares or more (Graudal, Thomsen, and Kjaer, 2001).

**Conservation stands should be better protected on land under secure long-term tenure, which can be managed by committed trained personnel and resources.**

### *4.6.3 Seed Source Selection*

Seed sources may often serve a dual function as seed production units and as conservation stands. A number of seed sources of priority species have been established (Table 3). Seed sources in concession areas are usually designated as special management areas, thereby protected under the Forestry Law.

Criteria for the selection of populations for seed source establishment are defined in the Plan, Strategy and Agreements on Seed Source Establishment (So Thea, 2001), and listed in Box 2. Seed sources are selected in collaboration with the Provincial Forest Office, forest concessionaires, Ministry of Environment, and/or relevant local authorities.

**Seed sources will be selected in forest areas, which are not subject to negative human activities.**

For practical management, a minimum stand size of 4 hectares is suggested for most forest tree species. The population should consist of at least 50 randomly interbreeding, unrelated, individuals to allow at least one copy of 95% of the alleles that occur in the population. For some species, this base figure needs to be multiplied by a factor of 2 – 4 to compensate for differences between actual and effective population size. Identified seed sources are inventoried, and their production capacities and degree of protection estimated.

**Box 2 –Criteria for the Selection of Populations for Seed Source Establishment**

- species is on the priority list
- seed collection is permitted
- possibility exists for protection and management
- knowledge of the origin of the seeds from which the stand was established
- the number of good, unrelated, phenotype mother trees within the area (>50)
- trees should be mature but not too old to maximise seed quality
- accessibility of the area
- minimal exposure to natural disaster
- protection against noxious/destructive animals
- free from pest and disease
- proven flowering, seeding and regeneration in the area
- no former exposure to logging activities
- social factors and practicality of seed source establishment
- potential for small seed sources to be protected by buffer zones

### *4.6.4 Seed Source Registration*

Selection of key populations is ongoing, with their locations recorded in the Seed Source Registration System of FA/CTSP (available at the CTSP office). The registration of protected seed sources should continue in order to encompass a network of stands of all priority species.

## 4.7 Identification of Appropriate Conservation Methods

Conservation of forest genetic resources can be described as evolutionary or dynamic when the genetic composition of tree species changes over time, allowing for adaptation to changing environmental conditions. Static conservation, on the other hand, is used to maintain specific genetic compositions.

***In situ* conservation is conducted at the site of origin and is the principle method for the conservation of forest genetic resources, whereas *ex situ* conservation takes place outside the native habitats of the populations. *Ex situ* is a more expensive approach, sometimes necessary in case of rapid forest loss and degradation. *Ex situ* activities generally complement *in situ* conservation.**

The advantages and disadvantages of conservation methods are illustrated in Appendix 3, and provide a base for the feasibility ratings illustrated in Table 2.

*In Situ* conservation objective reflects the level of diversity targeted, as follows (Graudal *et al*., 1997):

- **Conservation of ecosystems** – the conservation of many species, which may contribute to the conservation of environmental services, and the different levels of diversity and their interdependency. However, conservation of an ecosystem will only conserve a particular tree population adapted to the site. Associated problems relate to the scientific difficulties in the definition and location of

representative ecosystems, lack of knowledge and trained staff to establish sustainable management systems, lack of political support, and financial expenses involved. Outside protected areas, the best solution to the conservation of forest genetic resources would be through partnerships with rural communities.

- **Conservation of species** – endangered species are best conserved in their natural habitat or ecosystem, generally as national parks and protected areas. Sometimes conservation of certain species has to be complemented by *ex situ* facilities such as botanical gardens and arboreta.
- **Conservation of inter-population diversity** – conservation of the genetic variation within a target species. Most species require a network of populations adapted to different ecological and environmental conditions and thus assumed to harbour different genetic compositions.
- **Conservation of intra-population diversity** – among individuals of a population. Environmental, demographic and genetic factors influence the minimum viable population size. It is recommended that the population should be in the range of 500 – 1,500 in order to avoid inbreeding, conserve a specified proportion of genes with some defined probability, and conserve evolutionary potential. The density of reproducing trees will determine the required area for the conservation stand.

Where FA/CTSP seed sources are small, a buffer zone of secondary forest will greatly compensate for the lower number of trees in those areas.

Methods that may be considered for *ex situ* conservation include (Chin, 1993):

- **Gene conservation stands** – an area where trees, representing the gene pool, can be transferred from their natural environment and grown under cultivation
- **Field gene banks** (arboreta, botanical gardens) – an area where plants can be transferred from their natural environment and grown under cultivation.
- **Seed banks** – a common, practical and economic method of genetic resource conservation, and suitable for long-term storage. However, many tropical tree species produce recalcitrant seeds, not suitable for storage.
- **Slow-growth seedlings** – a growth chamber, or shaded field conditions are used to restrict the growth of seedlings. This method enables the storage of recalcitrant species seedlings for some years.
- **Pollen storage** – not a common method, but can complement other techniques. Pollen storage is valuable in tree breeding as it reduces the time required to cross desirable strains for tree species that take several years to flower.
- ***In vitro* gene banks** – a measure of success has been achieved with tropical tree species, but needs further refinement for conserving recalcitrant species (tissue culture, cryopreserved embryos, DNA).

The internationally recommended practice in the creation of a founder population, of 100, for *ex situ* conservation, is that seed be collected from 25 unrelated, distant seed sources (Graudal, *et al*., 1997).

A well-balanced forest genetic resource strategy should reflect an evaluation of the different methods and available resources, and the interactions illustrated in Box 3 (FORGENMAP, 2002).

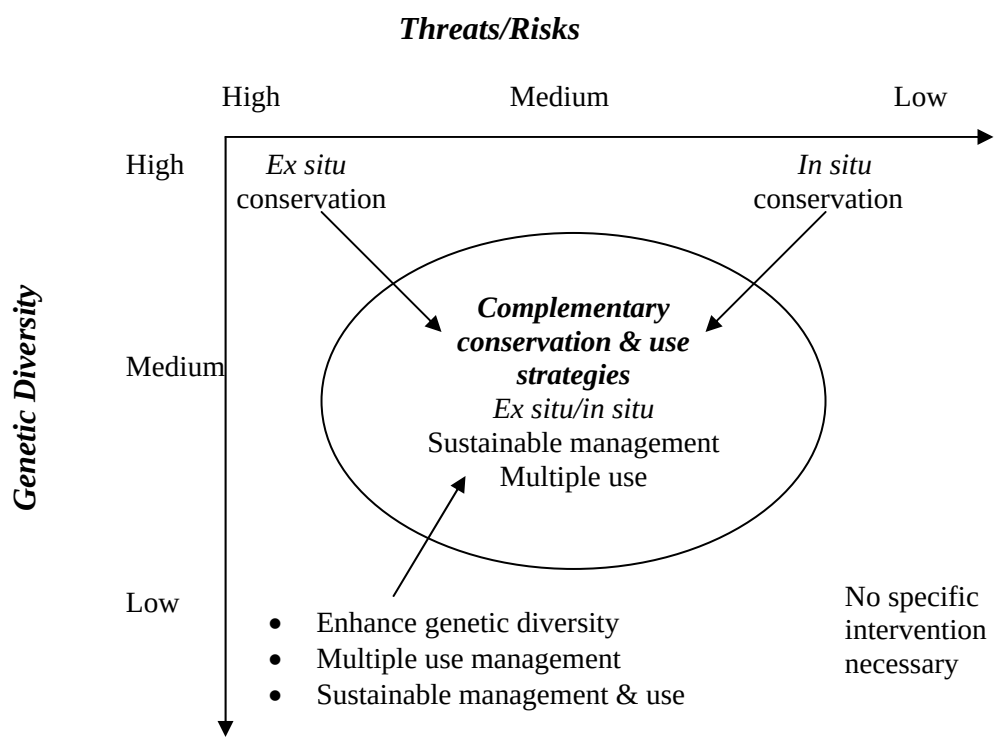
Table 2 – The Relative Feasibility of Different Conservation Methods for Different Purposes

| **Method of Conservation** | **Object of Conservation** | | | |
|---|---|---|---|---|
| | **Ecosystem** | **Species** | **Inter-population variation** | **Intra-population variation** |
| **Evolutionary conservation** | | | | |
| *In situ* : Protected areas | **** | ** | * | ** |
| *In situ* : Managed populations | IR | **** | **** | **** |
| *Ex situ* : Living conservation populations | IR | *** | **** | *** |
| **Static conservation (*ex situ*)** | | | | |
| Seed banks: orthodox seeds | IR | *** | *** | *** |
| recalcitrant seeds | IR | IR | IR | IR |
| Pollen banks | IR | ** | ** | ** |
| Tissue culture banks | IR | ** | ** | ** |
| Clonal archives | IR | * | * | ** |
| Botanical gardens and arboreta | IR | ** | - | - |

Feasibility ranking : IR Irrelevant *** High * Low
**** Ideal ** Medium - Very low

Source : Graudal *et al*., 1997

**Box 3 - Matrix of Forest Gene Resource Conservation Options and Approaches Against Threat/Risk and Genetic Diversity (after A-S. Ouedrago)**




Source : FORGENMAP, 2002

### *4.7.1 Methods of Conservation Recommended in Cambodia*

Within Cambodia, a mix of *in situ* and *ex situ* activities should be applied for forest gene resource conservation. The principal conservation method is *in situ* within natural forests, complemented in some circumstances by *ex situ* activities. *Ex situ* gene conservation stands may also be important for research on growth and yield of selected species and provenances, and as seed sources.

**Within the natural forests of Cambodia, *in situ* conservation is the preferred option, to be complemented, in some circumstances, by *ex situ* activities.**

#### **4.7.1.1** ***In situ***

By 2003, a total of 23 seed sources had been identified, which may also serve as gene conservation stands (Table 3). The establishment of more seed sources is recommended, and whenever possible, several priority species can be protected in the same location (see Section 4.8.3).

*4.7.1.1.1 Seed Source Establishment*

The process of seed source establishment is as follows:

1. Survey and identification of potential stands – based on seed source selection criteria (Box 2), the best stand is selected for establishment
2. Border demarcation – the seed source is marked by cutting tracks (2 metres wide) around its boundary. Wooden poles are inserted around the perimeter at 50 metre intervals, the upper parts of which are painted with red and white stripes.
3. Signboards are located at the nearest road junction, and at the seed source, to aid protection, recognition and awareness by local people.
4. Identification of the plus trees – selected trees are marked with an identification number, and other information such as height, age, crown dimension, and location (as needed) within the stand.

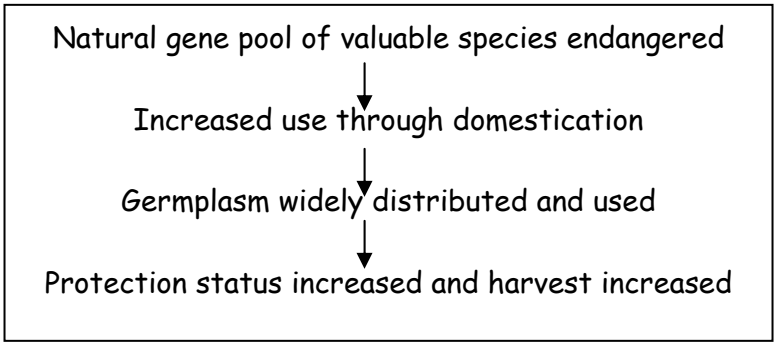
In general, the implementing levels of FA are responsible for maintaining seed sources in the state forest. Private lands may also serve as repositories for seed sources/gene conservation stands, for example, an agreement has been initiated with a landowner in Banteay Meanchey for forest gene conservation.

*4.7.1.1.2 Participatory Approach*

**A strong participatory approach is essential for *in situ* forest gene conservation, through the integration of conservation and local development efforts. Community participation in seed source management has been initiated at several sites supported by Ministerial Declarations.**

Within the Cambodian context, it is recommended to increase the utilisation of priority species (see Box 4). This will be achieved through the promotion of priority species in tree planting activities within forest restoration and rehabilitation, and on-farm. From the local development perspective, this model can help to meet local needs for tree products and services, or provide cash incomes from the sale of products. At the same time, genetic resources are conserved, and as harvests increase, the pressure on natural resources decrease (Kjaer and Nathan, 2000).

Box 4 - The Increased Utilisation Model



Community participation is strongly recommended in the conservation of forest genetic resources. Some experience exists as tree seed source management has been initiated in the following provinces, each representing a different type of forest management regime :

- Siem Reap – the seed source is within a community forest, recognised at provincial level, and supported by FAO.
- Kampong Thom – a seed source of a recalcitrant species is located within Colexim forest concession, and is protected through its designation as a Special Management Area. Two villages are located close to the source and villagers from one of these are involved in its management.
- Rattanakiri - two seed sources are found within natural forest utilised by the families of two villages, many of whom are keen to be involved in seed source management. The focus is on orthodox species, as the area is too remote for the collection and distribution of recalcitrant species. Five other areas have been identified as important seed sources, but the areas are very remote, a factor that might function as a protection measure.

Whilst active participation of local communities is a step towards successful *in situ* conservation, other influential factors are:

- appropriate social, economic and political conditions
- relevant biological information
- commitment and appropriate resourcing

(Thomson, Graudal and Kjaer, 2001).

Table 3 - Seed Sources in the Natural Forest

| No | Species | Area (ha) | Location | | | Number of Trees | UTM Coordinate |
|---|---|---|---|---|---|---|---|
| | | | Province | District | Commune | | |
| 1 | *Dalbergia oliveri* | 12.5 | Preah Vihear | Tbeng Meanchey | Parl Harl | 78 | 04 94 650, 15 16 781 |
| 2 | *Sindora cochinchinensis*<br>*Tariettia javanica*<br>*Shorea hypochra*<br>*Shorea vulgaris*<br>*Dipterocarpus costatus*<br>*Anisoptera glabra* | 117 | Kampong Thom | Sandann | Tumring | 100<br>39<br>22<br>19<br>396<br>323 | 05 51 500, 14 48 000 |
| 3 | *Pterocarpus macrocarpus* | 20 | Siem Reap | Chikreng | Khvao | 83 | 04 51 140, 14 84 668 |
| 4 | *Azadirachta indica* | 50 | Banteay Meanchey | Mongkul Borey | Phnom Tauch | 90 | 02 85 596, 14 84 344 |
| 5 | *Pinus merkusii*<br>*Fagraea fragrans* | 104 | Kampong Thom | Santuk | Kror Year | 72<br>70 | 05 31 601, 14 09 923 |
| 6 | *Dalbergia oliveri*<br>*Pterocarpus macrocarpus*<br>*Xylia dolabriformis* | 21 | Rattanak Kiri | O Chum | Cha Uong | 21<br>20<br>22 | 07 06 931, 15 20 149 |
| 7 | *Afzelia xylocarpa*<br>*Dalbergia oliveri*<br>*Pterocarpus macrocarpus* | 18 | Rattanak Kiri | Lumphat | Patang | 27<br>41<br>14 | 07 21 623, 15 15 900 |
| 8 | *Afzelia xylocarpa*<br>*Dalbergia oliveri*<br>*Shorea cochinchinensis* | 20 | Rattanak Kiri | Kaun Mum | Teun | 26<br>17<br>07 | 07 04 001, 15 04 648 |
| 9 | *Hopea ferrea* | 30 | Rattanak Kiri | Kaun Mum | Teun | 88 | 07 05 131, 15 05 403 |
| 10 | *Dalbergia cochinchinensis* | 50 | Siem Reap | Varinn | Sre Nauy | 67 | 04 00 757, 15 20 273 |
| 11 | *Dipterocarpus alatus* | 7 | Siem Reap | Angkor Wat | | 43 | |
| | ***17 species*** | **449.5 ha** | **5 Provinces** | **10 Districts** | **10 Communes** | **1 736** | |

*4.7.1.1.3 Stand Management*

A management plan should be developed for each conservation stand. Ideally, the individual plans are components of a broader forest or protected area management plan for the area in which the gene conservation stand is situated. Stand level management plans are best developed through a consultative process involving all stakeholders. Each plan should be comprehensive, with all the required activities clearly documented, including:

- basic information – maps, extent, boundaries, tenure status, owners, history, inventory, environmental characteristics
- reference documents on area and target species – biological inventories, census, ecological/genetic studies

- description of roles, responsibilities and rights of all those involved in management and use of the reserve area and its resources, including permitted and prohibited activities and uses
- programme, timetable and budget for monitoring and management of tree populations being conserved
- assessment of potential risks and threats to the species and a contingency plan to deal with these, including possible complementary *ex situ* conservation measures

(Graudal *et al*., 2001).

**Management plans are required for each conservation stand, which should be developed through a consultative process with stakeholders**

*4.7.1.1.4 Agreements and Legislation*

Appropriate legislation is required to officially protect gene conservation stands, and is presently under preparation for several seed sources. It is recommended that further legislative development will build on these experiences. Ministerial Declarations have been completed and approved for all sites on government-managed land for seed stands listed in Table 3. Stands within protected areas do not require further legislation, though they should be noted in the relevant management plans. Stands located on private land may require a contract between the State and the landowner.

Written agreements for the management of seed sources are made with local communities based on mutual benefits, which clearly define the roles and responsibilities of both parties. An example of such an agreement is located in Appendix 4.

The legal process to approve and protect seed sources and gene conservation stands is time-consuming. Therefore, it is recommended to process declarations in bulk.

**4.7.1.2 *Ex Situ***

Some conservation sites are remote and difficult to monitor and manage, and in some cases habitats have been destroyed. In such situations, establishment of *ex situ* stands may be appropriate. It could also be worthwhile to begin a domestication programme, which would better protect seed sources, provide a better seed source than the natural forest, and bring seed sources closer to the user (CTSP, 2003). *Ex situ* conservation stands are being established as seed orchards at Kbal Chhay and Bak Sna. Additional locations are under consideration for *ex situ* stand establishment.

***Ex situ* conservation could be appropriate where *in situ* stands are remote and difficult to protect and manage**

## 4.8 Organisation and Implementation of the Gene Conservation Strategy

### *4.8.1 Institutional Organisation*

The Forest Gene Conservation Strategy will be organised under the authority of FA. A possible setting could be the establishment of a specially created office, which could be allocated its own resources and structure. Current examples in the forestry sector include the Forest Concession Management and Control Pilot Project, the Wildlife Monitoring Group, and the GIS Unit. Establishment of such structures is the responsibility of the Director of FA, but could provide a focus for the implementation of the strategy after the completion of CTSP.

**An institutional framework is necessary for the implementation of the strategy, which can ensure the participation of a range of forest user groups.**

Roles and responsibilities of all stakeholders will be defined according to the forest management regime. The stakeholders in the Cambodian context include a number of diverse groups, whose wide-ranging views and expectations need to be harmonised. Efforts should be directed at involving local level, that is commune councils, communities and NGOs. The role of commune councils in forest resource management is presently uncertain, and therefore, it is crucial to forge links between the appropriate level of the new forest administration and the ongoing government decentralisation process.

### *4.8.2 Costs of Conservation*

Budgets will have to be elaborated for the implementation of the Forest Gene Conservation Strategy. Costs associated with the conservation of forest genetic resources may be divided into the following components (Graudal, *et al*., 1997) :

- conservation programme planning and administration
- demarcation and management of *in situ* conservation stands
- establishment and management of *ex situ* conservation stands
- establishment and management of storage facilities
- build up, management and utilisation of collections
- supportive research and development activities

Useful experience of costs related to gene conservation stands has been gained through the work undertaken by CTSP in seed source identification and establishment, and could be used as a base for future budgeting.

### *4.8.3 Implementation*

A number of activities in support of the forest gene conservation strategy has been undertaken or initiated. During 2003 – 2004, the following activities are planned for implementation (CTSP 2002):

- a national seed source register
- identification of seed zones based on gene ecological zones. Seed zones digitised and mapped
- contributions to the review of forest management concessions, to ensure that gene conservation areas are identified and designated as Special Forest Management Areas. Sustainable regeneration will be more achievable on larger areas, which could cover several species, thereby easing management budgets

- identification and establishment of more seed sources, preparation of relevant documents, agreements and declarations (Box 5)
- implementation and expansion of socio-economic models for *in situ* conservation

The Action Plan (Box 5), provides an example of activities and times necessary to establish a number of tree seed sources for conservation. In addition, management plans will be prepared for each seed source, mainly focusing on protection and silvicultural techniques. The management plans will be supported by technical guidelines.

**During the remaining project time, FA and CTSP should consider methods for integration of their conservation objectives into a broader framework in order ensure the sustainability of the conservation stands after termination of CTSP.**

**Box 5 - Conservation of Forest Genetic Resources**
***Pilot Action Plan***

| **Activity** | **2003** (weeks) | **2004** (weeks) |
|---|---|---|
| • Field trips to identify, survey and demarcate stands | | |
| Agreements with District Forest Offices and Communities | | |
| Kampong Thom | 4 | |
| Mondulkiri | 4 | |
| Ratanakiri | 4 | |
| Preah Vihear | 4 | |
| Koh Kong | 4 | |
| Kampong Speu | | 4 |
| Pailin | | 4 |
| Oddar Meanchey | | 4 |
| Documentation (2 weeks per stand) | 10 | 6 |
| **Total** | **30** | **18** |
| • Legislation | | |
| Prepare declaration (2 weeks/stand) | 10 | 6 |
| Prepare sub-decree for all stands | | 24 |
| Communication with hired lawyer | | 4 |
| Process documents for stands identified 2000 – 2002 | | 34 |
| **Total** | **10** | **68** |
| • Maintenance of 23 existing conservation stands | | 20 |
| • Establish ex situ conservation stands (11 species) | 13 | 7 |
| **Grand Total** | **53** | **109** |

There is a need to complement and upscale the current initiatives to cover a wider range of species over a broader geographical distribution area within Cambodia. It is hoped that the Forest

Gene Conservation Strategy will spur the development of an appropriate comprehensive programme.

## 4.9 Potential Regional Perspectives

Regional collaborative activities could increase the efficiency of national programmes by avoiding duplication of efforts on similar species and gene-ecological zones located across borders. They require close collaboration between governments for the maintenance and accessibility of conservation stands, to ensure sustainability of a regional strategy reflecting the needs, requirements and priorities of the individual countries.

**For Indochina, the scope of cross border *in situ* conservation is limited as most border areas are made up of watersheds (resulting in different gene ecological zones on each side of the border) and where this is not the case, the land is not forested.**

The Indochina Tree Seed Programme support will not continue after 2004, and therefore, implementation of a regional gene conservation strategy in the near future is unlikely. It is recommended that the Royal Government of Cambodia prioritise national conservation activities. The implementation of a national Forest Gene Conservation Strategy is important and urgent.

## *References*


Brouard, JS and John, SET, 1993, Enhancing Tree Seed Supply in Southern Africa, in International Symposium on Genetic Conservation and Production of Tropical Forest Tree Seed, Chiang Mai, Thailand, 14 – 16 June

Burley, J, 1993, Balance Between Development and Genetic Conservation, in International Symposium on Genetic Conservation and Production of Tropical Forest Tree Seed, Chiang Mai, Thailand, 14 – 16 June

Chin, HF, 1993, *Ex Situ* Conservation of Tropical Tree Species, in International Symposium on Genetic Conservation and Production of Tropical Forest Tree Seed, Chiang Mai, Thailand, 14 – 16 June

CTSP, 2002, Progress Report No. 9

CTSP, 2003, Proceedings of the 5th Regional Consultation of Tree Seed Projects in South-East Asia

Dany, C, 2002, Flora of Cambodia, CTSP

Dany, C, 2002, Monographs of 21 Priority Species, CTSP

Forestry Administration (FA), 2001, The Second Five Year Plan for the Forestry Sector 2001 – 2005

FA, 1999, The Cambodian Code of Practice for Forest Harvesting

FA/Cambodia Tree Seed Project, 2000, National Priority Tree Species Workshop, Phnom Penh, 15 – 16 August

Forestry Administration, 2003, Forestry Law

FORGENMAP, 2002, Conservation Strategy for Forest Genetic Resources of Thailand

Graudal, L, Kjaer, E, Thomsen, A, and Larsen, AB, 1997, Planning National Programmes for Conservation of Forest Genetic Resources, DFSC

Graudal, L and Thomsen, A, 1998, Institutional Development in Forest Genetic Resources, presented at the Premier atelier regional de formation en conservtion er l'utilisation durable des ressources genetiques forestieres en Afrique de l'Ouest, Afrique Centrale et Madagascar, Burkina Faso, 16 – 27 March

Graudal, L, Thomson, L, and Kjaer, E, 2001, Selection and Management of *in situ* Gene Conservation Areas for Target Species, in Forest Genetic Resources Conservation and Management, Volume 2, FAO/DFSC/IPGRI

Hald, S, Barnekow Lilleso, JP, and Sigaud, P, 2002, Regional Workshops on Conservation and Use of Forest Genetic Resources: Their Contribution to a Global Assessment of Forest Genetic Diversity, in Proceedings of the Southeast Asian Moving Workshop on Conservation, Management and Utilization of Forest Genetic Resources, 25 February – 10 March 2001, Thailand

IUCN, 1997, Cambodia: A National Biodiversity Prospectus, a Report to the United Nations Development Programme

Khorn, S, 2002, Distribution of Selected Tree Species for Gene Conservation in Cambodia, CTSP

Kjaer, ED, and Nathan, I, 2000, Three Approaches for Integrating Conservation and Development, presented at the Danida Workshop on Integrated Conservation and Development, Denmark, 1 September, DFSC

Royal Government of Cambodia (RGC), 2002a, Forestry Law

RGC, 2002b, Statement on National Forest Policy

RGC, 2002c, Cambodia's National Biodiversity Strategy and Action Plan, MoE/FAO/UNDP/GEF

RGC, 2001, Cambodia's National Report on Implementing the Convention on Biological Diversity, MoE/FAO/UNDP/GEF

So Thea, 2001, Plan, Strategy and Agreements on Seed Source Establishment (2002)

Theilade, I, 2002, Debriefing Note, following the Second Visit for the Gene Conservation Strategy in Cambodia, November

Thomson, L, 2001, Management of Natural Forests for Conservation of Forest Genetic Resources, in Forest Genetic Resources Conservation and Management, Volume 2, FAO/DFSC/IPGRI

Thomson, L, Graudal, L and Kjaer, E, 2001, Conservation of Genetic Resources in the Natural Environment, in Forest Genetic Resources Conservation and Management, Volume 2, FAO/DFSC/IPGRI

Thomson, L, and Theilade I, 2001, Protected Areas and their Role in Conservation of Forest Genetic Resources, in Forest Genetic Resources Conservation and Management, Volume 2, FAO/DFSC/IPGRI