Genetic conservation and plantations

Plantation forestry owes its success to biodiversity and must play a role in conserving it

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IN 1998, ITTO took an important step in the conservation of tropical tree species by funding ITTO project PD 16/96 REV. 4 (F) '*Ex situ* conservation of *Shorea leprosula* and *Lophopetalum multinervium*'. Conducted by the Faculty of Forestry at Gadjah Mada University in Yogyakarta in cooperation with the Government of Indonesia, the state-owned forest companies (PT Inhutani I–V) and Oregon State University in the United States, this project aims to: 1) avert declines in the genetic variability of indigenous timber tree species *Shorea leprosula* (red meranti) and *Lophopetalum multinervium* (perupuk) and 2) plan and implement *ex situ* conservation plantations of these two endangered species for use in future genetic improvement programs. Both species are of major economic importance; *S. leprosula*, in particular, is the most important commercial tropical species traded in the international market.

A third activity of the project was to plan, organise and sponsor a major international conference on *in situ* and *ex situ* conservation of commercial tropical trees. This conference was duly held last June in Yogyakarta on the campus of Gadjah Mada University; it was attended by over 120 people from ten nations and featured more than 50 invited and voluntary papers and also a number of poster presentations. This article summarises the results of the conference and emphasises the relationships between genetic resource conservation, plantation forestry and sustainable forest management.

High aspirations: a seed-collector employed under ITTO PROJECT PD 16/96 REV. 4 (F) harvests the fruits of a fine specimen of *Lophopetalum multinervium* (perupuk) in Kalimantan, Indonesia. *Photo: Gadjah Mada University*

Why genetic conservation?

Ultimately, the sustainability of a given ecosystem depends upon the maintenance of diverse and healthy gene pools of the organisms that constitute it. Since dominant forest tree species are often the 'keystone species' for maintaining biodiversity in tropical forests, the conservation and maintenance of their genetic diversity assumes paramount importance for conservationists and forest managers alike.

Also important is the need to preserve wild-type gene pools for domestication in plantations; having a diverse gene pool from which to select will help in the search for varieties that are resistant to pathogens, pests and environmental pollutants and have high growth rates and good wood qualities. For example, the huge diversity within and between eucalypt species has greatly assisted the establishment of highly productive plantations in Brazil (see article pp 14–15).

Lessons can be learnt from the agricultural experience: the genetic identities of almost all modern domesticated crop species are now quite different from those of their wild progenitors. Indeed, in many cases, those ancestral species no longer exist, severely limiting the improvements that can be made. The importance of maintaining a broad and viable genetic base, therefore, is an accepted principle among forest scientists and managers alike. But, of course, the *real* challenge is to successfully put that principle into practice so that there is an appropriate balance between conservation and sustai4nable production.

Ex situ *vs* in situ conservation

Ex situ conservation is the conservation outside its natural habitat of a species' genetic diversity; it can certainly play an important role in guarding against biodiversity loss. Botanical gardens, arboreta, seed orchards and banks, clonal banks, common gardens, provenance tests, progeny tests and, more recently, DNA libraries are all examples of *ex situ* genetic conservation. Even some commercial forest plantations—

certainly those established with seedlings derived from a relatively broad genetic base—represent a type of *ex situ* conservation, one that is especially important for species with rare or endangered natural populations.

However, all but the most insular of breeders will acknowledge that such *ex situ* practices, while important, are only 'back-ups' or vehicles for research convenience: *in situ* conservation—conservation of a species and its genetic diversity within natural reserves—is needed to successfully conserve wild gene pools of tree species on a long-term basis. Importantly, only natural conservation areas of adequate size and appropriate distribution and management provide the needed elements of intra- and inter-specific competition and natural selection that drive evolutionary processes (which in turn begets diversity). Moreover, *in situ* conservation areas serve as both a reference point and source of materials in the design and implementation of reintroductions and ecological restoration projects.

Speakers at the Yogyakarta conference observed that *in situ* and *ex situ* conservation strategies for a species should be complementary. One or both may be necessary to conserve a particular species or population.

Combining improvement and conservation

Genetic improvement and conservation should also be complementary. *In situ* conservation, if properly planned, can contribute significantly to an *ex situ* tree improvement program by providing a sustainable source of genetic material, while the tree improvement program can provide the motivation and resources for successful *in situ* conservation. If a conservation reserve system is to adequately represent the genetic diversity of an ecosystem, information on gene frequencies and population size is critical. The proper design and maintenance of *ex situ* plantings are necessary to maximise genetic recombination while minimising outside contamination. Maintaining separate breeding populations based on specific traits of interest is one effective way to maintain diversity and minimise the loss of low-frequency alleles (genes for particular traits).

Breeding and supportive genetic conservation activities are expensive; cooperative approaches should be encouraged to reduce costs, save time and maximise efficiency. The results of several existing programs, presented at the conference, indicate both the scale of threat to the genetic resources of several species and a promising degree of success in alleviating those threats. Results also show that when properly planned and conducted, combined genetic conservation and improvement programs can have favourable cost:benefit ratios and can serve to improve the public's perception of plantation forestry. Because of the high costs of such programs, the constraints imposed by land tenure systems, and the economic status of many of the potential producers of genetic materials, conference participants agreed that some level of local and national (and international) government support for conservation activities is appropriate and necessary. This is especially true for those forest species and systems that are not currently utilised by forest industries but are nonetheless of great value to local communities and the nation.

Various biotechnological tools for improving tree-breeding and for understanding the phylogeny and ecology of populations and species were discussed at the conference. Participants noted that some powerful molecular techniques could be useful in conservation strategies by elucidating genetic diversity, population structure, gene flows and mating systems with reasonable accuracy. Research on such technologies needs to be further strengthened.

Representatives from several ASEAN nations summarised genetic conservation activities in their countries. It was gratifying to learn that there is not only an awareness of the need for such efforts in the region, but also quite a bit of organised activity to establish both *in situ* and *ex situ* conservation areas for rare and endangered indigenous species as well as for species that are critical for sustainable commercial plantation forestry.

The role of local people

At the Yogyakarta conference, a vision for genetic conservation was presented and discussed, one where the forest is understood not only as an ecosystem—a biophysical entity—but also as a 'soft system' comprising the interactions among all levels of society and the forest landscape. This underlines the importance of involving local communities, farmers and small companies in producing and conserving genetic materials. Besides maintaining the genetic materials on local farms, communities could grow trees in smallholdings to complement and extend the resources of forest industries.

Many farmers are interested in tree-planting, but while they have indigenous knowledge they often lack technical skills and tools. Increasing awareness of the importance of using high-quality planting materials and providing access to those materials and technical assistance is essential for capacity-building in rural communities. Such a program would improve the success of genetic conservation efforts, in general and especially for species of higher value.

In situ conservation, if properly planned, can contribute significantly to an ex situ tree improvement program by providing a sustainable source of genetic material, while the tree improvement program can provide the motivation and resources for successful in situ conservation.

A new centre?

We hope that the information shared and contacts made at the Yogyakarta conference will lead to even more regional-level cooperation on the genetic conservation of tropical forest trees. In that context, conservation projects such as the ITTO-sponsored effort to develop effective strategies and systems for the *ex situ* conservation of *Shorea leprosula* and *Lophopetalum multinervium* in Indonesia will play an important role in teaching and demonstration, as well as in conservation. With continuing concern, interest and support from government, industry and the international forestry community, this work could form the nucleus of a regional centre for the conservation of tropical tree genetic resources, which was proposed at the conference. Such a centre could make valuable contributions to the basic knowledge of species' biology and to the sustainability of both natural and planted forests in the tropics.