

Replanting the World's Tropical Forests

All over the tropics, governments are worried about the continuing loss and deterioration of forests. In the past, the greatest concern was loss of economic forest resources such as timber and firewood, but these days, concern extends increasingly towards the role forests play in conserving soils and biodiversity. It was to focus on these conservation aspects of reforestation that a tropical forest symposium was held in Taipei, Taiwan from September 24th to 26th, 2001. Organized by the Taiwan Forestry Research Institute, the meeting was attended by 39 participants from Bangladesh, Burkina Faso, Canada, Cambodia, Ghana, India, Indonesia, Japan, Malawi, Malaysia, Nigeria, Philippines, Sri Lanka, Taiwan, Thailand, United States of America and Vietnam. The organizers assembled a distinguished array of speakers and provided generous support of participants from developing countries. Sub-titled "The Art and Practice of Conservation Planting," the symposium was divided into four main sections: tropical forest conservation; tropical tree seed research, propagation of tropical trees for conservation and physiological ecology of trees and conservation planting.

In a welcome address, Jenq-Chuan Yang, Director General of the Taiwan Forestry Research Institute, stated that sub-tropical Taiwan maintains 52 percent forest cover, including 14 percent man-made forests. As well as providing habitat for more than 4,100 vascular plant species, these forests play a vital role in protecting this mountainous nation from devastating landslides during tropical storms and earthquakes, which frequently ravage the island. To protect these vital forest resources, the government has established an impressive system of protected areas, covering 8.5% of the country's area.

Disappointingly, reforestation with exotic tree species was a recurring theme during the meeting. For example Ming-Jou Lai and Robin Rose described the "miraculous" transformation of Kinmen Island (178 km²), 277 km west of Taiwan. Fifty years ago, the island was a desert, but from 1949 to 1971, thousands of soldiers planted 6.6 billion exotic trees: *Acacia confusa*, *Casuarina equisetifolia* and *Pinus elliotii*. Ming-Jou Lai defended the use of exotics for the reforestation of Kinmen: "it does not matter if you start natural succession with native or exotic species, it's the second generation of trees that matters". He pointed out that natural regeneration beneath *P. elliotii* is diverse and vigorous. *P. elliotii* seedlings do not establish beneath the pine canopy, so the species is gradually replaced by natural regeneration. Stands of *C. equisetifolia*, however, have not done so well and now need to be replaced. A study of remnant old trees revealed that deciduous forest was probably the island's former dominant vegetation type. Therefore, tree species selected to replace the degenerating *C. equisetifolia* plantations included *Litsea glutinosa*, *Melia azedarach*, *Ficus microphylla*, *Pistacia chinensis* and *Acacia confusa*.

Thai delegate, Bunvong Thaitua provided a presentation on the Highland Reforestation Project of the Royal Project Foundation, which has close technical and financial links with Taiwan. This project is introducing exotic tree and bamboo species from Taiwan and Japan and investigating the silviculture and environmental impact of man-made plantations. Agro-forestry systems, combining these exotic trees with coffee or cereals are being developed to improve the soil, ameliorate the microclimate and provide an eco-tourist attraction. In terms of yields, *Paulownia taiwaniana*, inter-cropped with wheat and barley, is the most promising agro-forestry system tested so far.

Although such exotic plantations can rapidly restore canopy cover, improve soil conditions and increase villagers' incomes, their contribution to the conservation of biodiversity is limited, until they are replaced with natural regeneration. Their continued promotion reflects a lack of research to survey the highly species-rich tree floras of most tropical countries to find fast-growing indigenous tree species that can maintain ecological relationships with the indigenous fauna, with which they co-evolved. As our understanding of the productivity and ecological suitability of many indigenous tree species improves, it is disappointing to see the continued promotion of exotic tree species at international meetings, with apparent disregard for the well-known inherent dangers associated with introducing exotics into fragile tropical ecosystems.

Tree planting programs rely on an adequate supply of seed and several participants complained that difficulty in obtaining sufficient quantities of high quality seed is seriously limiting conservation plantings. Sometimes, seed supply is limited by lack of flowering. Richard Pharis gave an impressive presentation to overcome this problem by manipulating flowering with chemicals. Application of gibberellins, combined with artificially stressing plants, has successfully been used to induce early flowering in temperate conifers and probably has wide application for tropical gymnosperms. This technique dramatically increases the profitability of seed orchards. Ben Wang, one of the world's leading seed experts, reminded the audience of the proper precautions that must be taken when collecting and handling tropical tree seed. He identified the timing of seed collection and proper seed processing and storage as critical factors determining the success of reforestation programs. Seed technologists can establish the best scientific recommendations for efficient seed collection, but they are often unable to ensure that these recommendations are always carried out. Therefore, Ben Wang emphasized the need for scientists, policy makers and practitioners of seed collection to work in concert, to ensure the highest quality of future forests.

One way seed supply can be improved is through seed storage, but many tropical timber tree species have recalcitrant seeds, which cannot tolerate drying or storage at low temperatures. Aderonke Somade and J. O. Gbadebo showed that maximum germination of three Nigerian Mahogany species was obtained when seeds were stored at ambient temperatures for up to three months. Storage at 5°C and -17°C reduced viability. Bobby Varghese and S. C. Naithani showed that both dried and non-dried *Madhuca indica* seeds could not tolerate cold temperatures, confirming the recalcitrant nature of this species. Tsan-Piao Lin suggested a possible biochemical mechanism to explain recalcitrance in tropical tree seeds. He found that differences in the phospholipid composition of the plasma membrane might determine desiccation tolerance. Compared with orthodox seeds, recalcitrant seeds have a higher PE (phosphatidyl-ethanolamine) to PC (phosphatidylcholine) ratio and higher saturated to unsaturated fatty acids.

Several papers dealt with propagation of tropical tree seedlings for reforestation programs. Vo Tri Chung, from Vietnam, emphasized the need to combine traditional indigenous knowledge with modern technology to devise the most effective methods of propagation. Suphawan Wongkamjan *et al.* outlined various innovative techniques to propagate framework tree species for forest restoration in the northern highlands of Thailand. Framework tree species are those which rapidly shade out herbaceous weeds, whilst attracting seed dispersing wildlife into planted areas, thus accelerating biodiversity recovery. Most treatments that increased permeability of the seed coat (such as scarification and soaking

in sulphuric acid) significantly increased germination rates. They also described a novel, simple technique to propagate framework tree species from cuttings in individual plastic bags

After seedlings have been successfully propagated, consideration of seedling physiology can increase planting success. Ochiai Yukihiro looked at the habitat preferences of seedlings of various dipterocarp species. He emphasized that physiological site preference is different from ecological site preference. Species that may be physiologically capable of growing in a certain site may be absent due to ecological competition. Such considerations must be taken into account when planning enrichment planting in secondary forests. Yau-Lun Kuo and Chung-Teng Cheng found that a higher concentration of CO₂ in the forest understorey compensated for low light levels, thus enabling small seedlings (2–10 cm tall) to maintain high rates of photosynthesis, despite the shade. The response to elevated CO₂ levels was much greater for shade-tolerant tree species than for shade-intolerant ones. Sureeporn Kerdkankaew *et al.* also examined CO₂ uptake by trees from the aspect of carbon sequestration to address the issue of global warming. They found that CO₂ uptake was higher in *Azadirachta siamensis* than in *Pterocarpus macrocarpus* and the rate of CO₂ uptake was dependent upon irradiance and temperature.

In addition to the technology of reforestation, several papers addressed sociological and community aspects. Samuel Kainja described a successful project organized by the Wildlife Society of Malawi to develop alternative livelihoods for villagers living near forests in Mwanza District. After wide consultations with local village leaders, a fruit juice factory was constructed and bee keeping and the rearing of guinea fowl were promoted. Interest in these new economic activities has soared, reducing pressure on remaining areas of natural forest, while forest tree nurseries have been established to produce seedlings for forest restoration. J. B. Lal outlined the so-called “goal-dimension matrix” method for planning reforestation projects. This involves compiling a table with goals as column headings (stability of the physical environment, productivity and equity in the social environment) and “dimensions” as row headings (ecological, technical, socio-economic and institutional). This encourages stakeholders to consider all impacts of forest management on both the environment and the local human community. This approach was echoed in another paper from India. Uma Melkania stressed the need for forest managers in Aranchal Pradesh to consider all direct and inter-linked issues for better protection of the diverse forests of this eastern Himalayan region of India, including social, legal, economic and cultural considerations.

The meeting included several “country review” papers. Nguyen Hoang Nghia presented an overview of forest conservation in Vietnam. Despite the ravages of wars, Vietnam retains about one third of its area under some kind of forest. He called for a ban on both logging natural forest and the replacement of natural forest with exotic plantations and recommended that innovative silvicultural techniques, such as the framework species method, should be developed to encourage biodiversity conservation in reforestation programs.

Romulo Aggangan and R. Serrano stated that more than half of the Philippines’ total land area is classified as forestland, but only about 5% is old growth forest. Upland poverty is the primary cause of forest loss, so the government is promoting community-based forest management to promote sustainable forestry. As of 1999, 4,659 various agreements to preserve community forests had been accepted. In order to revitalize the forest industry, the government has various schemes to encourage participation by the private sector,

whilst promoting responsible forest management. Aggangan and Serrano identified the need for a nationwide nursery system and longer periods of land tenure as top priorities for improved forest management in the Philippines.

Bambang Hero Saharjo discussed the hot issue of forest fires in Indonesia, responsible for elevating the country to one of the largest carbon polluters in the world. In 1997–98, 9.7 million ha were affected by fire. Fire is used, mostly illegally to clear land for crops or plantations, such as oil palms. Lack of law enforcement is the main problem. Many landowners evade detection by satellites by burning only when there is dense cloud cover.

Tuck Y. Chin concentrated on the technical standards of forest management that Malaysia is developing to meet its obligation to implement sustainable forest management as a member country of the International tropical Timber Organization. A few of these include a legal requirement for forest management plans, regulating logging by setting the allowable cut, retention of four seed trees per ha and the routine use of mycorrhiza inoculae. To minimize impact when logging, climbers are cut 1–2 years before tree felling.

Syphan Ouk surveyed the stand structure of logged-over forest in Cambodia, to determine the best methods to rehabilitate such areas. Cambodia currently retains 58% forest cover, but the forest is disappearing at a rate of 1.55% per annum; up from 0.56% 10–30 years ago. Ouk found that logging reduced merchantable species to 0.14–6.50% of the species component and removed mature seed trees, thus limiting future regeneration. He recommended enrichment planting with indigenous dipterocarps, in strips beneath the remaining forest canopy.

Several papers were of high quality and will be of general interest to foresters. A volume of proceedings is being produced and anyone interested in obtaining a copy should contact Robin Rose (robin.rose@orst.edu). Although most of the papers were interesting in their own right, the conference seemed to lack logical flow, with disconnected subjects following each other and little sense of continuity. Lack of round table discussions meant that there was little opportunity to critically analyze or synthesize the information presented into a coherent set of conclusions. There was no attempt to produce a plan of action or to determine priority areas for further research. In this age of instant publication on the Internet, I question the value of expensive and largely “passive” symposia with no interactive working groups to produce some kind of original output.

The main criticism of the meeting, however, must be that it did not live up to its title: “The Art and Practice of Conservation Planting”. Conservation was hardly mentioned at all, whilst actual planting of trees was barely touched upon. As in so many international forestry meetings, when tree planting was brought up, commercial tree species and exotics were usually the only species mentioned. Biodiversity was largely ignored and I left the symposium wondering why the word “conservation” had been included in the title at all.

Stephen Elliott

Forest Restoration Research Unit
Department of Biology
Faculty of Science
Chiang Mai University
Thailand 50200