

Bringing trees back in the Philippines



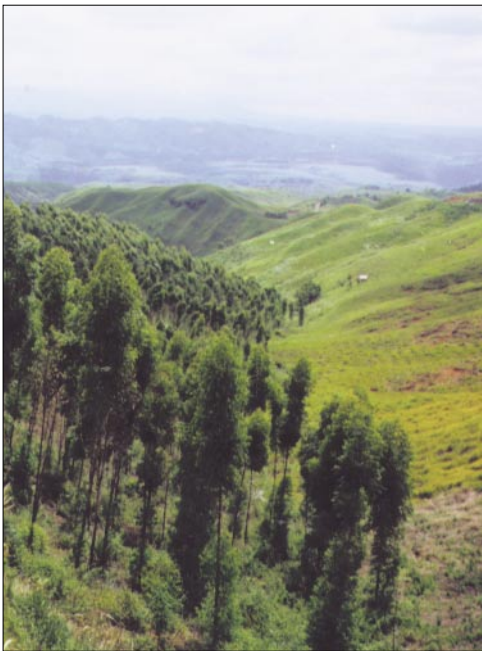
Seventy years ago 60% of the Philippines was covered with forest, today it is less than 20%. As part of efforts to restore some of the tree cover ACIAR research is providing the basis for successful tree establishment.

Reforestation is recognised as an urgent need in the Philippines following the clearing of most of the native forest cover. Large-scale tree planting efforts have, however, been much less successful than hoped. Research has identified the reasons for this disappointing outcome, and provided the basis for successful tree establishment even on severely degraded sites.

ACIAR Research Notes summarise results and benefits from selected ACIAR projects, with the aim of ensuring the widest possible application. We invite extension and research departments to reprint or translate either the whole document or any part considered useful.



Australian species can tolerate fires. Above a fire in a Philippines trial of Australian eucalypts in April 1998, below the same forest has recovered in October 1998.



Major reforestation efforts by government organisations, private companies and farmers — many of them funded by loans from international agencies — have been far from universally successful. A review published in 1994 found that only about 42% of the total area planted had become successful, productive plantations. Research supported by ACIAR investigated the reasons for this disappointing outcome and has helped provide the basis for much better results in the future.

Through the active involvement of a network of collaborators, the project was able to cover most of the major timber producing regions of the Philippines. The collaborators — who kept in touch via planning and review meetings, site visits and exchange of information through a newsletter — included a broad range of research groups, industrial plantation companies and community groups.

Tree selection

A key goal was to improve the matching of tree species, and provenances within species, to site characteristics — principally soil and climate. To this end, the researchers evaluated trees and shrubs with a variety of end uses in trials at 12 locations (see map). As fuelwood is by far the largest use category in the Philippines, exceeding the wood requirement for all other purposes by a factor of about ten, emphasis was placed on fast-growing species that should thrive in farm woodlots as well as industrial plantations. Several of these species can also provide high value timber for sawlogs, veneers, plywood and furniture.

Preferred plantation species in the Philippines have been the fast-growing native eucalypt bagras (*Eucalyptus deglupta*); two trees originally from South America, gmelina (*Gmelina arborea*) and mahogany (*Swietenia macrophylla*); and teak (*Tectona grandis*) from Burma and India. As well as these, the project trials included fast-growing eucalypts, acacias, casuarinas and grevilleas from Australia (and in the case of one of the most promising eucalypts, *E. urophylla*, Timor). Many are potential producers of timber and pulp as well as fuelwood. A key advantage of some of the Australian species is their ability to grow in soils with low fertility; while the native and naturalised species generally will not establish, grow or thrive in degraded soils dominated by cogon grass, some of the Australian species have shown a strong capacity to do so. Also, importantly, many are tolerant of fire, the cause of more than 70% of plantation tree losses in the Philippines.

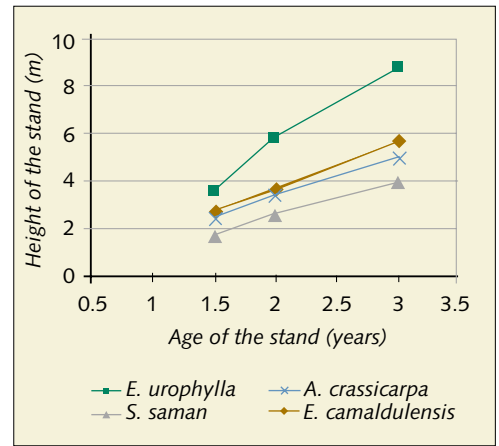
Major reforestation efforts by government organisations, private companies and farmers — many of them funded by loans from international agencies — have been far from universally successful.

The performance of trees in trials at two poor sites (Juanay and Tigbawan, Cebu) and two relatively fertile sites (Matalom and Ormoc, Leyte) illustrates the growth potential of various species. Average tree heights at ages up to 3 years are shown in the graphs.

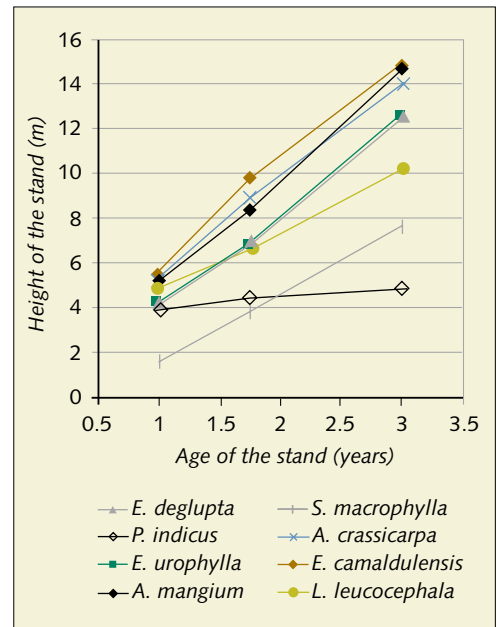


The project site (top) at Matalom on the Island of Leyte was a disused paddock unable to support crops. The other two photos (below) show the site three years after planting species and provenances from Australia and Papua New Guinea—some trees had reached 15 m.

Cebu trials (poor sites)



Leyte trials (good sites)





These two photos demonstrate the difference in performance between (above) well nodulated *Acacia aulacocarpa* and (below) a non-nodulated provenance.



Among the fastest growing trees were the Australian species *Acacia mangium*, *A. crassicarpa* and *Eucalyptus camaldulensis*, and *E. urophylla* from Timor. The height growth of these generally surpassed that of the native *E. deglupta* (bagras) and *Pterocarpus indicus* (nara) and the naturalised *Albizzia (Samanea) saman* (acacia or rain tree), *Leucaena leucocephala*, and *Swietenia macrophylla* (mahogany). And the growth was not only upwards; at 3 years of age the average diameter at breast height of the Australian species on the Leyte sites was double that of the native and naturalised species.

Fast growing trees planted at 1000 stems per hectare require thinning after 3 years, so that the best trees can grow on to their potential and produce higher value products such as sawlogs. The ACIAR trials indicated that 3 year old thinnings from plantings of some Australian species can provide valuable light construction timber as well as fuelwood.

Growing the trees

In addition to choice of the best species for a site, successful plantation establishment depends on use of high quality genetic stock, good nursery practice, effective land preparation including weed control, appropriate fertilisation and good silvicultural practices. Other factors that need to be taken into account in the Philippines include the likelihood of fire damage and of typhoons, which strike on average every three to four years in the northern and central parts of the country.

To date, most of the seedlings sown by farmers have come from poor, inbred genetic stock. Attempts to collect, store and germinate seed of superior individual trees have had little success. However, clonal propagation has been developed by plantation companies in the Philippines and used for large-scale plantings of gmelina and eucalypt hybrids. This technology offers the opportunity to multiply superior timber trees for use in plantations and on farms.

Other factors that need to be taken into account in the Philippines include the likelihood of fire damage and of typhoons.

An outcome of the ACIAR research that will help improve the quality of the tree seedlings offered for planting is new potting mixes made from inexpensive, locally available materials. Other developments at the nursery stage include ways to better train roots and to harden off and grade plants. Requirements for nutrient additions in nurseries have been determined, and procedures for large-scale inoculation of acacias with nitrogen-fixing *Rhizobium* bacteria established.

The ability of acacias to form *Rhizobium*-containing nodules on their roots and fix nitrogen is important both for their own growth and for improvement of the soil. The contrasting performance in trials on Mindanao of very well nodulated acacias and others without nodules (pictured on page 5) illustrates the impact nitrogen fixation can have; the nodulated trees grew about twice as fast as the others. Initially these tree were regarded as two different provenances of *Acacia aulacocarpa*, but following a taxonomic revision they now belong to separate species — *A. peregrina* and *A. disparrima*. More work needs to be done on the matching of *Rhizobium* strains with their acacia hosts. Strains isolated from Australian and Papua New Guinea acacias in their natural habitats have generally proved much more effective than those naturally present at planting sites in the Philippines and other countries.

Researchers also investigated prospects for boosting the growth of eucalypts by inoculating seedlings with mycorrhiza — fungi that help plants take up nutrients from the soil — in the nursery. The soil under land cleared of trees many years previously is generally deficient in mycorrhiza, so inoculated plants should have a considerable advantage there. Again, a key consideration is matching trees with an appropriate inoculum strain. Considerable success was achieved in the greenhouse in producing seedlings with mycorrhizal roots, but production of inoculants for commercial use has so far proved problematic and lasting benefits from inoculation remain to be demonstrated in the Philippines.

The research confirmed the critical importance to tree establishment of effective weed control. Weeds need to be

The research confirmed the critical importance to tree establishment of effective weed control.



Mrs Madeline Dios, a farmer from Bukidnon, Mindanao, has learnt the advantages of nitrogen-fixing trees. Here she holds roots of her *Acacia mangium* trees to display the nitrogen-fixing nodules.

cleared to a radius of one metre around each planting hole, and controlled for at least 6 months after planting. Holes should be dug well in advance of planting, with dimensions of at least 30 ¥ 30 ¥ 30 cm in stony and infertile soils and 20 ¥ 20 ¥ 20 cm on better land. Fertiliser should be applied in a ring around each tree at planting and 3 to 6 months later.

Tree nutrition

The project developed two approaches to determining fertiliser requirements for successful plantation growth — identifying nutrient deficiencies in the soil and assessing the nutrient status of trees. The soil method, refined by researchers from the Visayas State College of Agriculture (ViSCA), involves monitoring the growth of ‘indicator’ plants in pot trials. The pots contain soil from the test site with all essential nutrients except one — a different nutrient for each pot — added. Variations in growth between the pots show which nutrients are deficient in the soil or if there are toxicities.

The technique revealed deficiencies at most of the trial sites, and showed these were severe at some sites. The findings provided the starting point for fertiliser rate trials to quantify nutrient addition requirements. Researchers performed tests with various forms of fertiliser, including organic types.

Analysis of the concentrations of nutrient elements in leaves provided the starting point for developing ways to identify deficiencies in growing trees. Leaf sources were trees from sites with known deficiencies and from other sites with an apparently adequate nutrient supply. Also included were trees displaying obvious symptoms of inadequate nutrient uptake — notably the ‘yellow mangium’ syndrome in *Acacia mangium*. This condition was found to have a wide range of possible causes — nitrogen, phosphorus, potassium, iron, manganese, sulphur and boron deficiencies or an excess of nickel or chromium.

The ‘data bank’ built up covering more than 1000 leaf samples from 28 species is a valuable resource, defining deficient and adequate concentration ranges for the different nutrients. It revealed, for example, severe potassium deficiency in eucalypts and acacias at sites in Mindanao and Cebu. Adding potassium fertiliser had a rapid positive impact on both the leaf symptoms and plant growth.

In related work, researchers grew acacias and eucalypts in solutions providing nitrogen, phosphorus and potassium at six concentration levels and calcium, sulphur, magnesium, iron and boron at three levels. They photographed and wrote descriptions of the deficiency symptoms that developed, and chemically analysed leaves so that nutrient content readings could be matched to the symptoms. The photographs and findings will provide the basis for a field guide that growers will be able to use to assess the nutrient status of their trees.



Nutrient deficiency trials at Queensland University were able to reproduce the ‘yellow mangium’ syndrome in *Acacia mangium* by omitting essential nutrients—in this case potassium.

Spreading the word

The primary focus of the research was large-scale industrial plantations, but it has had valuable spin-offs for farmers interested in growing trees. Experience shows that communities adopt new tree growing technologies quickly once farmers have seen how effective they can be, and in the Philippines six communities are now applying findings from the project. They have established nurseries and field plantings to evaluate the best species and provenances for their farmers to grow.

Findings are being applied in the planting and management of communal areas as well as farms. In one example of sustainable community-based forest management, the 106-member Agroforestry Development Multipurpose Cooperative at Alcoy, Cebu, maintains 911 hectares of reforested land in an area of poor soils. The farmers grow cash

Experience shows that communities adopt new tree growing technologies quickly once farmers have seen how effective they can be.



Six communities in the Philippines are now applying the project findings. Here Mrs Dilinila from Bukidnon in Mindanao is pictured with seedlings of *Eucalyptus robusta* produced from seed in her nursery.

crops such as corn, carrots, onions, beans and cabbage, but come together once a week to undertake community forestry activities. In conjunction with the ACIAR project selected tree species have been planted over 4 hectares on four farms to test their suitability for these soils, which comprise a shallow layer of topsoil over limestone. At another cooperative, at Paraclete in Leyte, the farmers planted 120 hectares with species selected from the ACIAR trials in the first year after establishing their nursery — a truly remarkable performance.

A key outcome of the research has been the successful introduction of Australian tree species across a range of sites in the Philippines. As in the examples noted earlier from Cebu and Leyte, early observations indicate that many are doing substantially better than the species normally planted; some trees reached a height of 15 metres, with good stem form, only 3 years after planting. The success of the trials has encouraged the establishment of seed orchards and seed stands of the most promising Australian species, to provide growers with high quality seed. In addition, some non-government organisations have decided to adopt Australian plantation species. Planning is under way for a pilot development phase that will be a major step towards widespread implementation of the research outcomes.

This Research Note is based primarily on work conducted between 1993 and 2000 in two ACIAR projects. The first, 'Tree establishment technologies in the Philippines' (FST/1992/008), involved The University of Queensland; Queensland Forest Research Institute; Department of Forest Biological Sciences, University of the Philippines at Los Baños; Department of Environment and Natural Resources, Philippines; Ecosystems Research and Development Services, Philippines; Bukidnon Forests Inc; C. Alcantara and Sons Inc; and Visayas State College of Agriculture. Partners in the second project, 'Tree production technologies for the Philippines and tropical Australia' (FST/1996/110), included in addition Philippine Council for Agriculture, Forestry and Natural Resources Research and Development; Provident Tree Farms; Paper Industries Corporation of the Philippines; and Aqua Industries Inc. In both cases, the Australian project leaders were Dr Peter Dart of the School of Land and Food Sciences, The University of Queensland, and Dr John Simpson of the Queensland Forest Research Institute.

Philippine leaders of one or both projects were Dr Angela Almendras, Visayas State College of Agriculture, Dr Elvero Eusebio, Ecosystems Research and Development Services, Dr Cesar Quiñerez, Bukidnon Forests Inc, Dr Discora Melana, Department of Environment and Natural Resources, Dr Reynaldo De La Cruz, Department of Forest Biological Sciences, Dr Edilberto Nasayao, Department of Environment and Natural Resources, Dr Juliana Libuit Baggayan, Department of Environment and Natural Resources and Dr Segundino Foronda, Philippine Council for Agriculture, Forestry and Natural Resources Research.

Further information on these projects and other ACIAR projects is available from:

Communications Unit
ACIAR
GPO Box 1571
Canberra ACT 2601
Australia

e-mail: comms@aciarc.gov.au

web address: **www.aciarc.gov.au**

Writing Bob Lehane, Science Communication Services in consultation with Dr Peter Dart, University of Queensland.

Design: Design ONE Solutions

The Australian Centre for International Agricultural Research (ACIAR) helps developing countries solve their agricultural problems and build up their research capabilities by commissioning research partnerships between Australian and developing-country research institutions.