China and ACIAR – a constant in times of change

Terraced crops at Dingxi in western China: growing demand for produce has put stress on water resources as well as on productive lands.

The pace of change in China over the past two decades has been rapid. One constant throughout that period has been the partnership in agricultural R&D between China and ACIAR. When ACIAR first began working with Chinese researchers in 1984, China was isolated from much of the rest of the world. During the late 1980s and 1990s the Middle Kingdom began to engage on a global level, economically and socially. Today China is a full member of the World Trade Organization and economically a global giant.

Over the past 20 years the China–ACIAR partnership has included research on the selection of Australian trees suited to Chinese forestry, studies of livestock production and diseases, and the adoption of new agricultural management practices for land and water resources. Adoption of conservation tillage in some central western provinces has been encouraged to help reduce wind-blown dust in Beijing, as well as to improve crop productivity.

Geographically, the focus of ACIAR's program has now shifted towards western China, including the Tibet Autonomous Region, in line with the poverty-reduction emphasis of Australia's international development cooperation policy. This shift recognises the extensive economic growth that has already taken place in eastern China.

Smallholder farmers in western China are among the poorest in the country. Their incomes can be raised through increases in productivity, derived from improvements to the quality of crops, livestock and forestry. The need for this productivity improvement to be sustainable and to ensure past increases in productivity remain sustainable is central to ACIAR's research in China. Agricultural practices and growing demand for produce have put stress on water resources as well as on productive lands.

Policy and technical interventions are now targeting improved management of these resources and agricultural and forestry environments. This includes more effective allocation and management of irrigation.

ACIAR's past program has played a role in building agricultural research capacity in institutions across the country. In addition to the training opportunities provided within projects, Chinese researchers were amongst the first to benefit from ACIAR's John Allwright Fellowship scheme for postgraduate study in Australia. Today the focus for capacity-building activities has also shifted westwards, with the award of a fellowship to a researcher from the Tibet Autonomous Region.

Australia and China recognise the mutual benefits of continuing close technical cooperation. As the human and financial resources of China's national agricultural research system have improved, Chinese institutions are now able to contribute more of the costs of new research and development activities. And ACIAR can help to build links with other funding sources, both Australian and Chinese.

The nature of the ACIAR–China relationship is changing. The partnership continues to be one of major importance for ACIAR, expected to deliver benefits to both countries for many years to come.

Getting the best from eucalypt plantations

It needed some top-quality Australian research to get eucalypt plantations accepted in Asian countries, reports **Janet Lawrence**

It is hard to imagine eucalyptus trees as the cause of widespread outrage. But back in the 1990s communities in south India and north-east Thailand rose in protest at the establishment of eucalypt plantations in their regions. Part of the reason for this protest was their conviction that eucalypts were thirsty trees that sucked all the moisture from the soil, to the detriment of their crops planted nearby.

When such rumours abound, they can circulate quickly. This was so in southern China at that time, where eucalypt plantations had become a major source of hardwood pulp and timber products. About a million hectares had already been planted, and the area continued to grow by about 10 percent a year. But alarm bells were ringing, because the plantations appeared to deplete the groundwater needed for dry-season irrigation of rice and sugar cane, and also to increase soil erosion.

However, the Chinese forest scientists knew little about how much water the trees were using, or even how to ascertain the water balance of eucalypt plantations. Once armed with this knowledge, the scientists still needed to determine the effects of silvicultural choices – including site preparation, tree spacing and rotation length – on plantation water balance.

Time for action

In this environment an ACIAR-funded project began late in 1996, to address problems of excessive water use. It also focused on plantation growth because, despite the introduction of more suitable tree varieties and selective tree breeding, the productivity of these plantations appeared to fall after two or more successive tree crops. There was also evidence of a decline in soil fertility at the sites.

Practices such as removing litter and understorey vegetation, and harvesting the root systems along with the rest of the tree, were thought to be the main causes of the decline.

The Australian research organisations – the Victorian Government's Centre for Forest Tree Technology, the University of Melbourne's Institute of Land and Food Resources and CSIRO Land and Water in Canberra – teamed up with China's Research Institute for Tropical Forestry, the South China Institute of Botany and the China Eucalypt Research Centre.

The Australian project leader, Dr Jim Morris from the Centre for Forest Tree Technology, brought his 20 years of research experience in the physiology and ecology of forest trees in both natural and plantation environments. He had already collaborated in another ACIAR project that introduced technologies to assess water uptake and to trace water movement through plantations in Pakistan and Thailand.

"When I first began to measure tree water-use early in my career it was a cumbersome and rather inaccurate business," says Dr Morris. "The development of the heat pulse method for measuring water use changed all that. In the course of this project we introduced the method to the Chinese scientists, who now have the skills to carry out the measurements themselves."

Predicting regional impacts

Modelling is an excellent means of interpolating data collected at a small number of sites over a few years into conclusions for regional impacts of plantations over longer periods.

Chinese and Australian collaborators worked together on a previously published mathematical model (3PG) that enabled prediction of water use in plantations in relation to growth and site management. Their joint efforts led to further development of the model, which they now refer to as ThreePG+. It is now fully functional with user interfaces in both English and Chinese. Dr Morris describes the outcome of this phase of the project as a "raging success".

The project also aimed to develop and apply a large catchment model in the Leizhou Peninsula and also in Victoria. By studying

how water moves through the landscape the effects on water flow of changes such as the introduction of plantations can be assessed.

In practice, the work did not make the progress anticipated across the whole Leizhou region, so the scientists scaled down their efforts and targeted a small sub-catchment of the Upper Nandu River for modelling using Topog, an existing hydrological model.

The project team obtained high-resolution satellite imagery of the central Leizhou Peninsula as a basis for mapping land use and relating the small catchment behaviour to the regional landscape. The experimental area and surrounding plantations comprise a suitable location for future research into management for maintenance of plantation productivity.

In Victoria, the newly developed large catchment model has been successfully applied and the work continues beyond the life of the project. The model is sensitive to the elements of plantation establishment and management and also to the position of a plantation within a catchment. It will provide answers to questions such as: "If I place a plantation in this region, what will be the effects on stream flow in the catchment?" This larger-scale catchment hydrological model, developed in Australia, also has application in the Upper Nandu catchment, to interpolate the small catchment observations of groundwater depth and the distribution of plantations.

Putting people first

As was the case in India and Thailand, recommendations for changes in forest management may impact on people. Many on the Leizhou Peninsula depend on the plantations for employment or as a source of forest products. Recognising this, the project team gave a high priority to surveying the socio-economic importance of plantations to place the analysis of the modelled results in an economic context. Benefit-cost data collected through surveys and interviews helped ease concerns.

The project teams held workshops where they sought the views of plantation managers, farmers and research workers on their best options for improving productivity and sustainability of plantations. Since the workshops, the scientists have undertaken biophysical and economic modelling that incorporate these options, leading to forest management recommendations that take into account implications for both plantation water-use and productivity.

"Our research provided strong evidence that plantations on the Leizhou Peninsula do not cause excessive lowering of water tables, and have a relatively modest annual water uptake in this humid tropical environment," Dr Morris says. "The modelling work has made it possible to predict how plantation water-use will change in response to management alternatives implemented to improve productivity and sustainability.

"Economic analysis of the model outputs has identified the likely long-term profitability of the alternatives."

The project emphasised the value of technology transfer, and the Australian scientists actively assisted nine of their Chinese colleagues to find short-term placements in suitable Australian research institutes. Back home in southern China, they have built a strong base for policy development, and have greater capacity to identify the actions needed to maintain and improve the productivity of eucalypt plantations.

Research pays off for China's eucalypt plantations

ACIAR's investment in China's eucalypt plantation industry is reaping a handsome return, according to a recently published independent economic assessment.

The author of the assessment, Martin van Beuren, from the Australian-based Centre for International Economics, concluded that a suite of seven ACIAR-funded projects spanning 20 years had played a central role in creating today's plantation industry.

He believes the A$12 million (A$18m at today's value) investment in ACIAR projects since 1985 played a central role in developing the industry in China. ACIAR's investment accounts for around 78 percent of the total research undertaken, stretching back to the AusAID funded China–Australia Afforestation project of 1981.The total research investment, from all donors including the A$12m from seven ACIAR projects, is expected to generate a net present value of A$1.3 billion over the 30-year period from 1985 to 2015. This is a benefit:cost ratio of 57:1.

China has been working to expand the area under eucalypt plantations since 1981, but the trees used performed poorly. Australian forest scientists realised that, with help, the Chinese could grow much better-yielding eucalypts – by choosing varieties better suited to the conditions and adopting better cultivation techniques.

Thus in 1985 ACIAR funded the first projects to help develop China's eucalypt plantation industry. Since then, ACIAR research has introduced more than 100 eucalypt species (and countless variants of each species) for selection trials, resulting in a valuable genetic base from which the Chinese foresters can now choose varieties suited to specific purposes.

Other ACIAR projects have studied cultivation techniques, how to match tree species to the most suitable sites, tree nutrition (including the introduction of beneficial root fungi that aid nutrition) and water management.

The eucalypt plantation industry in China is now expanding rapidly. Over the past three years about 88,000 hectares have been planted annually, giving an area of 1.5 million hectares under eucalypts – about twice that of Australia. China's trees are yielding on average 20 cubic metres of wood per hectare annually – triple the yield of the species grown in 1985.

All this expansion has coincided with a series of beneficial policy reforms in the forestry sector, along with a booming domestic economy. Other countries are now investing in China's plantations, paper mills and fibreboard factories.

Determining stem weight of a harvested eucalypt as part of a comprehensive tree biomass assessment.

Previous page: plantations on higher ground surrounding agriculture in narrow valleys, may be expected to influence water supply from surface run-off and shallow groundwater.

The research has also brought benefit to rural people in southern China. They are growing eucalypts as a cash crop or participating in the income-generating activities spawned by this thriving industry.