Thinking outside the box

ACIAR contributions cut across all sectors, from fisheries on the high seas to aquaculture, cropping, livestock and forestry.

AQUACULTURE

BARRAMUNDI WITH A SIDE SERVE OF LOTUS FLOWER

BY DR GIO BRAIDOTTI

Native water plants such as the lotus, *Nelumbo nucifera*, are proving proficient at remediating waste aquaculture water for recycling back into ponds, including Queensland's inland barramundi ponds, which constitute the state's largest inland aquaculture industry.

The bioremediation potential of plants native to Australia and Papua New Guinea (PNG) was described in an ACIAR project and addressed an issue identified by the Australian Barramundi Farmers Association as a major priority area in need of innovation.

The beauty of the ACIAR solution is that the plants themselves possess commercial value. The lotus, for instance, has nutritional, medicinal and ornamental value. Thus new horticulture industries can be developed as a by-product of sustainably recycling aquaculture pond water.

This work was a continuation of the ACIAR-funded scoping study 'Development of capacity for aquaculture of indigenous fish species in Papua New Guinea', which sought to assist inland aquaculture development in PNG and Australia in an environmentally and culturally sensitive way. This included targeting herbivorous native fish species for aquaculture to avoid the need for expensive feeds.

However, water availability and the quality of the discharge water proved a limiting factor to aquaculture development. Barramundi were then used as the culture species in trials of bioremediation using aquatic plants undertaken by the Queensland Department of Agriculture, Fisheries and Forestry (QDAFF), led by Dr Evizel Seymour.

The aquatic plants tested are common to both PNG and Australia—duckweed (*Spirodela punctata* and *Wolffia angusta*) and lotus (*N. nucifera*). Water savings were achieved with both.

While duckweed produced water savings of 22%, lotus proved much more effective, producing astonishing savings of 62%. The plants were also proficient at removing waste nutrients, including 45% of ammonia nitrogen, 35% of total nitrogen, 19% of total phosphate and 32% of all suspended solids.

Importantly, fish growth rates were not affected by water re-use.

"Reducing environmental impacts and increasing ecological sustainability are important elements of aquaculture in Queensland," Dr Seymour says.

"Water re-use and water discharge quality to the natural environment are factors currently concerning the aquaculture industry, especially inland barramundi farming."

The Great Barrier Reef Marine Park Authority is increasingly scrutinising farming practices as part of efforts to protect the quality of river water that flows onto the reef from land-based activities.

Environmental requirements in Queensland are becoming more stringent and farmers are required to move towards zero discharge to the environment under both state and federal policy and legislation.

For the trials, native lotus seed was sourced from Ross River in Townsville, Queensland, and duckweed from a barramundi farmer's ponds. Both have potential for commercialisation. For example, uses for duckweed as an animal feed are well documented.

PHOTO: 123RF.COM

Bio-Tech Waste Management Pty Ltd (1998) trialled duckweed as a feed for chickens, ducks, sheep, fish and abalone. Additionally, numerous studies promote duckweed as a low-cost feed for tilapia, but none have actually compared the costs of duckweed production to other feed sources.

In developing countries where feed ingredients may be unobtainable and labour is the only commodity, duckweed may be a viable feed source to provide protein. This may be relevant to highland Papua New Guinea, where protein supplies are short.

The lotus has been consumed in its various processed forms throughout Asia and quality product from Australia was expected to capture the interest of Asian markets. All parts of the lotus are used in Asian medicine; the leaves and flowers contain various aromatic substances and the rhizomes and seeds are high in calcium and kalium (potassium).

"The leaves, flowers, seeds and the parts of the root system known as rhizomes can be used in food and medicine and, of course, lotus is a popular ornamental plant," Dr Seymour says. ■

ACIAR project: FIS/2004/065

FISHERIES

SEAFOOD LOVERS HELP CHAMPION TUNA'S FUTURE

BY DR GIO BRAIDOTTI

Australia and Indonesia share migratory stocks of yellowfin and bigeye tuna, but information gaps surrounding these species and their associated fisheries are hampering sustainable fisheries management.

Wild yellowfin tuna are among the largest tuna species, reaching weights of about 180 kilograms. They often travel in schools with similarly sized companions, other tuna species or dolphins, whales and whale sharks. Unlike most fish, tuna are warm blooded and their warm muscles make them incredibly strong swimmers, reaching speeds of up to 80 kilometres per hour.

Indonesia's take of tuna and tuna-like species is highly significant on the world scale, accounting for 15% of the total catch in the Indian Ocean—in excess of 800,000 tonnes in 2008. The export value of Indonesia's tuna was about US$250 million (A$263 million) .

Over the past 20 years or more, the number and size of target tuna species in individual vessel catches has been declining. Fleets now need to operate further from traditional fishing grounds to achieve profitable catches.

The commercial longline fishery alone had about 1,100 vessels active in 2010. There is also concern about the rising number of fish aggregating devices (FADs) in Indonesian waters, which attract fish such as yellowfin tuna, skipjack tuna and Spanish mackerel as they migrate through the Indo–Pacific. The devices are increasing fishing pressure on stocks of juvenile tuna and the likelihood of unsustainable fishing practices.

In a previous ACIAR project that reviewed Indonesia's Indian Ocean tuna fisheries, both countries agreed that the best approach to increased cooperation was through institution building, technical cooperation, training, skill sharing and developing capacity by improving practices and procedures for data management and reporting.

If sustainability of tuna fisheries as a whole can be achieved, the potential benefits are enormous. The current project seeking to achieve this goal is headed by Dr Craig Proctor, of CSIRO Marine and Atmospheric Research.

The project involves a population structure study of yellowfin and bigeye tuna species, which will help determine how to best assess and manage fisheries harvesting these stocks.

This includes investigating current deployment of FADs and their implications for the fisheries. The project is scheduled to run until 2016. ■

ACIAR project: FIS/2009/059

FORESTRY

SEEING THE FOREST AND THE TREES

BY DR WENDY HENDERSON

ACIAR funds a suite of forestry research projects in South-East Asia aimed at increasing the value of plantation-grown trees to smallholder growers and their communities. The projects are led by Dr Henri Bailleres from the Queensland Department of Agriculture, Fisheries and Forestry, and Professor Barbara Ozarska from the University of Melbourne.

Challenges faced by South-East Asian growers include legal requirements for certifying that timber has come from legal sources, improving competitiveness in international markets, and the lack of income over the years trees need to mature combined with the market reality that older trees are more valuable.

Much ACIAR-funded research is addressing the question of whether timber from short-rotation plantations—5–10 years old rather than decades old—can be used for high-value wood products such as furniture and quality building materials.

Short-rotation trees are not harvested in Australia, but Dr Bailleres says they could be, with great gains for the industry.

The potential benefits to Australia are many, especially since investment in the Australian forestry sector has severely declined over the years. As a consequence, innovations successfully developed and trialled overseas are being welcomed by growers in Australia.

The researchers too are benefiting, not only from the increased knowledge base but also from extended research networks.

Dr Bailleres says that much of the generic research on silviculture, processing, gluing and veneer products is mutually beneficial. Valuable insights have also been gained on fast-growing plantations and lean manufacturing—how to get 'more from less'.

The research has demonstrated effective and affordable ways to grow and process young trees and reduce wastage. Professor Ozarska says the amount of wastage can be drastically reduced using innovative approaches, including peeling logs for veneer products and making valued composite materials from offcuts.

ACIAR's whole-of-value-chain approach has also highlighted inefficiencies in the industry that result from players working as separate entities.

PHOTO: 123RF.COM

Dr Bailleres and colleagues recently discussed the ACIAR forestry research with HQPlantations in the industry. As a direct result, the company has changed its tree-growing practices and the products it is aiming to produce.

Growers are now more confident in the potential of new markets for small logs. ACIAR research projects demonstrate that processing technologies and markets are evolving faster than the trees grow. This is a game-changer for growers and foresters.

Dr Bailleres says ACIAR's research will go a long way towards improving Australia's forestry future if growers, processors and manufacturers agree to adopt new and more adapted ways of doing things. ■

LIVESTOCK

CLIMATE CHANGE EXACERBATES THE LIVESTOCK FEED GAP

PHOTO: 123RF.COM

BY DR GIO BRAIDOTTI

A livestock project in South Africa is providing ACIAR with opportunities to help adapt agriculture to a drying climate across southern Australia, particularly the south-west, which has experienced a 15% reduction in rainfall since the mid-1970s.

The idea is to mitigate feed gaps experienced by livestock through the use of new forage legumes and their nitrogen-fixing root-nodule bacteria (or rhizobia). This includes bringing into production legumes native to dry regions in Australia and South Africa, including legumes collected from the fringes of the Kalahari Desert.

The project has been underway since 2006 in partnership with South Africa's Eastern Cape Province. The project is led by Professor John Howieson, an internationally recognised expert and Foundation Director of the Centre for Rhizobium Studies at Murdoch University in Western Australia.

Professor Howieson specialises in root-nodule bacteria as commercial inoculants for agricultural legumes and in developing and domesticating new legumes for sustainable agriculture, including the commercially released 'Eliza' serradella.

He says that legumes and rhizobia can be thought of as nitrogen factories that are currently producing nitrogen worth in excess of $2 billion to the Australian economy. The ACIAR project is attempting to extend these benefits by collecting native legumes and rhizobia, testing them as pasture and identifying combinations that can return to previously productive, now-abandoned arable land.

With funding from ACIAR and assistance from collaborators in South Africa, the Centre for Rhizobium Studies has been domesticating shrubby perennial legumes collected from the fynbos (the natural shrubland) of the Western Cape. Lebeckia is the most advanced example of this.

"This perennial legume, collected from South Africa, is adapted to very infertile sandy soils, and has now been grazed successfully through the summer of 2011, and we are moving to development of three major evaluation sites in the wheatbelt of Western Australia," Professor Howieson says.

"Rhizobial ecology studies have identified and overcome challenges to developing a rhizobial inoculant for lebeckia. I expect the species and its unique nodule bacteria to now become a commercial reality and anticipate commercialisation in 2014–15."

Australia too boasts a large array of native legume species. Work at the centre has been redressing a lack of information about the relationships between these native legumes and their root-nodule bacterial symbionts, particularly in Western Australia, and studying the microbial diversity of native legume-nodulating bacteria.

"The centre has conducted several studies to better understand the microbial diversity of native legume-nodulating bacteria," Professor Howieson says.

"One approach has been to identify root-nodule bacteria with the potential for agricultural applications as inoculants on existing legume crops. Another is assessing the use of indigenous root-nodule bacteria with provenance legumes to rehabilitate long-term degraded sites in dryland areas. Members of the centre have also studied the diversity of root-nodule bacteria populations on the legumes of the state's south west."

He also applies this expertise to ACIAR's SIMLESA project (Sustainable Intensification of Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa) and he is on the steering committee for a US$20 million (A$21 million) project—'N2Africa: Putting nitrogen fixation to work for smallholder farmers in Africa'—funded by the Bill and Melinda Gates Foundation. ■

ACIAR project: LPS/2004/022

NEWS IN BRIEF

Aquatic farming

In 2012 there were about 20 active projects in ACIAR's fisheries portfolio: 70% dealing with aquaculture and the remainder covering wild harvests. Key concerns relate to the responsible management of wild-capture fisheries, better use of existing harvests, the development of productive and sustainable aquatic farming systems, innovative resource management and market-related risks. The program is committed to active engagement with relevant local communities, resource managers, extension agencies and policy makers in project design and execution to promote informed local ownership and effective engagement. The geographic focus is South-East Asia, Papua New Guinea and Pacific Island countries.

THE VIRTUAL FARM

ACIAR ACTION Increasingly, Australian scientists use computer simulation technology to help analyse complex agricultural systems. Central to such efforts is an internationally recognised software package developed with ACIAR support—the Agricultural Production Systems Simulator (APSIM). It contains a suite of modules that allow advanced simulation of agricultural systems and cover a range of plant, animal, soil, climate and management interactions. Through the APSIM Initiative, the package undergoes continual development, with new capability regularly added. ACIAR's role in its development dates to a research project between Australia and Kenya from 1984–93. At that time, ACIAR supported CSIRO efforts to build simulation capability, particularly of dryland farming systems, which resulted in technology that contributed to the development of APSIM. Since 1995, ACIAR has supported further development of this technology through additional projects in India and Africa. Besides helping to improve farm, land and water management, APSIM has found applications internationally, including at the International Maize and Wheat Improvement Center and the International Crops Research Institute for the Semi-Arid Tropics, which have applied it to improve farming systems in India and southern Africa.

PHOTO: 123RF.COM