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SUSTAINABLE AGRICULTURE FOR THE FUTURE

Across the world, the landscape on which agriculture produces food and materials for clothing and housing is a resource under pressure. More sustainable use of agricultural resources is a global issue, and research partnerships are reaching across national and geographic boundaries to foster improved whole-farm-system approaches as the demand for food and fibre increases world-wide.

In this issue of *Partners* we highlight the important link between good natural resource management and food security. We focus on ACIAR-supported initiatives and partnerships which are delivering sustainable approaches to agriculture, with examples of projects that demonstrate that environmental sustainability can also help smallholders increase their productivity.

Improving global food security is an important aim of ACIAR, and has been highlighted in a recent Australian Government 'Food Security through Rural Development' initiative announced in the recent 2009-10 Budget (see page 27). Its aim is to lift agricultural productivity in developing countries by working with other donors and research institutions using environmentally sustainable approaches.

As ACIAR Commissioner John Williams outlines on page 4, the challenges facing agricultural science are immense, but sustainability is achievable if scientists and producers can develop agriculture in a wider ecological framework.

In this issue we report on research in India and Australia that is both improving soils and reducing environmental damage through use of organic fertilisers (page 6), helping farmers rehabilitate their land in Aceh (page 10) and ways farmers in the Philippines are reducing soil erosion and increasing their incomes by planting harvestable hedgerows (page 12).

Other reports cover ACIAR-funded work in the Philippines that is reducing pesticide run-off into waterways, and also being applied in South Australia (page 16), and helping to identify suitable locations for sea-cage aquaculture to reduce environmental impacts (page 23). Another report is on research in Papua New Guinea that is helping communities develop sustainable harvesting strategies for their timber resources (page 24).

Farmers and scientists have been working on combining sustainability with profitability for a long time. The work of solving these problems continues, through ACIAR and a host of other organisations, in Australia and in the Asia-Pacific region. ■

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Partners in Research for Development is the flagship publication of the Australian Centre for International Agricultural Research (ACIAR). *Partners* presents articles that summarise results from ACIAR-sponsored research projects, and puts ACIAR research initiatives into perspective.

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Farming's resource base is being squeezed by competing land-use demands and urban spread.

BY JOHN WILLIAMS & BRAD COLLIS*

The need for food production gains is as great today as when science delivered the famine-averting Green Revolution in the 1960s. Then, the answer was high-input farming sustained by higher-yielding seed varieties, better pest control and soil nutrition. Today, evidence is mounting that the productivity of many of these farming systems is again struggling to be sustained.

The new green revolution is facing a new set of challenges focused on the shrinking resource base. Agriculture's resource base—its land, water, nutrients, and its people—can no longer be derived from or function in isolation to the surrounding natural landscape.

This leaves agricultural science with perhaps its greatest challenge yet: to meet rising global demand for food, animal feed, fibre and fuel, when the production of these basics is being eroded by competing land use demands, soil degradation, water scarcity, pollution, pests and weeds pressure, climate change, and rising energy costs.

The achievements and merits of the Green Revolution are fading into history, even as many still naively assume we can continue to feed the world on the back of these historic successes. To the contrary, there is mounting evidence of an increasingly complex, food/environmental crisis in the decades ahead.

Previously the easy answer was to bring more land under cultivation to solve issues of population growth and market expansion. Today, the land itself is under threat; in many places disappearing completely beneath accelerating urban development. Added to this, almost two billion hectares and three billion people are struggling against high and increasing levels of land degradation. One way or the other we are losing land, and water, faster than we can find new areas to farm or new water resources to tap.

Pressure on food supplies is already driving agricultural expansion into unsuitable or inappropriate areas—regions of low arability or the forests, wetlands, peat lands, savannahs and grasslands that are crucial for biodiversity. The planet's ecological functions are being damaged at the very time they should be being repaired to help us meet climate change and the imperative for wide-scale carbon sequestration.

We are learning, slowly, that there is a limit to agriculture's resource base. For instance, at current rates of use, reserves of phosphorus—an essential component of up to half of all



PHOTO: BRAD COLLIS

ENVIRONMENTAL FARMING

the new agriculture

The challenges facing agricultural science are immense, but sustainability is achievable if scientists and producers can develop agriculture in a wider ecological framework

fertilisers—may be depleted in as little as 50 years.

The unequal distribution of food and inevitable conflict over control of the world's dwindling natural resources present enormous political and social challenges to governments and policy makers. The mismatch is real and could have frightening consequences as the unstoppable forces of climate change and world population (projected to expand from 6.7 billion to 9.2 billion by 2050) meet.

HOLISTIC SOLUTIONS

How then do we achieve the seemingly unachievable? How do we increase agricultural productivity while protecting the natural assets that will sustain production long into the future?

The first step is to look at ecological, energy and water systems as a whole to understand the impacts, or the footprint, of food production on our natural resource base. This core message is finding advocates among international policy-setters, including the World Bank in its *2008 World Development Report: Agriculture for Development*, the 2008 report from the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), and the United Nations' Food and Agriculture Organization (FAO). All are pointing to the need for urgent change to secure the agricultural, ecological and scientific foundations that support food production.

Science and innovation that strengthens sustainability, while improving productivity and on-farm profits, is possible. Such systems have been developed in Australia and widely adopted by grain growers who are moving increasingly to conservation farming techniques, such as no-till farming—improved agronomy through more sophisticated crop rotations and integrated weed and pest management options that rely less on chemicals. These have all been in response to environmental stresses such as soil erosion, dryland salinity, more frequent drought and declining rainfall generally.

Much of the science behind these farming innovations is a consequence of Australia's capacity to invest expertise and excellence into agricultural research. ACIAR draws on this knowledge and expertise to help smallholder farmers in less developed countries who are struggling against similar environmental stresses and production constraints but do not have access to the same scientific muscle. In partnership with developing countries, ACIAR-supported scientists are exploring a wide range

of soil–plant–water dynamics that improve our understanding of the many landscapes in which we farm and the diverse agro-ecological mosaics of crops and natural habitats.

A feature of ACIAR's approach is to view farming communities holistically, encompassing social, cultural, policy and economic factors that affect agriculture's performance. This systems and community-wide approach is particularly important when research projects straddle diverse land use and a diverse management of the resources that support crops, livestock, forestry and fisheries. The organisational systems and infrastructures needed to regulate food, feed and fuel production in this way are also being studied and improved.

Over the past 20 years ACIAR has earned international respect for its effectiveness in building research and extension alliances that deliver lasting benefits to the communities with which it engages. Through its in-country projects and its postgraduate scholarships it has always placed a high priority on capacity building. But as successful as this has been, ACIAR and its partners continue to face the need to increase the body of available expertise as demand increases for new answers, be they biological alternatives to fossil-fuel-based agrichemicals or the unrelenting need to keep plants and animals a step ahead of pests and diseases evolving their way around agriculture's defences.

A new generation of geneticists and plant breeders must be attracted to the challenge, and be trained—and even then, all of their work will come to naught if the resource base is not secured.

All this requires new science and a new generation of agricultural scientists able to address the needs of the world's rural communities who, it is often forgotten, sustain all of humanity.

ACIAR'S SPECIAL ROLE

ACIAR exists to help communities develop more productive and sustainable agriculture where vulnerable farming systems and poverty are intrinsically linked. The emphasis is on building working partnerships at policy, research and extension levels—from international bodies, such as the 15 research centres of the Consultative Group of International Agricultural Research (CGIAR),

through to in-country specialists and village communities. It is a successful, systems-wide approach that is making progress because it gives smallholder communities access to appropriate agricultural science and expertise.

One example is ACIAR's on-the-ground support for the growth and spread of Landcare in the Philippines. By changing the way farmers manage their sloping lands, income-earning 'crops' are being grown as hedges whose principal role is actually to stabilise soils and stop erosion (see report page 12). Three provinces in the Philippines now have extensive Landcare networks that are helping farmers to move from subsistence food production to crop surpluses that pay for healthcare, education and other living improvements.

This collaborative, research-driven approach is working as a proven model at a critical time when climate change is adding to the challenge of making farming systems more resilient and capable of actually affording to put in place environmental programs.

At the base of much of this work (be it breeding more climate-tolerant and pest and disease-resistant crops, or improving water and soil management) is the imperative of securing agriculture's resource base—the environment, landscapes and communities that sustain farming.

ACIAR's record of 'making a difference' is showing that it is possible to create stronger agricultural systems that contribute to healthy and productive landscapes. It is not easy, but it is essential.

However, the traditional scope of agricultural science may no longer be enough to achieve the required dual goals of secure food production and a healthy natural resource base. 'Agricultural science' needs to start encompassing a broader suite of disciplines that integrate agriculture into the social, environmental and economic variables that will shape farming's capacity to feed and clothe eight or nine billion people without exhausting agriculture's life-support systems. ■

** John Williams serves as Commissioner for ACIAR and the NSW Natural Resources Commission. He is also a member of the Wentworth Group of Concerned Scientists.*

Brad Collis is editorial director of Coretext and author of Fields of Discovery, the history of CSIRO.

Science and innovation that strengthens sustainability while improving productivity and on-farm profits is possible.



SOILS AND CLIMATE GAIN FROM FERTILISER'S FLIPSIDE

An India–Australia research partnership is showing it is possible to produce more food while reducing fertiliser-related damage to the surrounding environment

BY GIO BRAIDOTTI

A project to help smallholder Indian farmers improve their fertiliser management could have an environmental spin-off half a world away in Australia by revealing the potential for urban green waste to lower Australian agriculture's emission of nitrous oxide, a significant greenhouse gas.

The project set out to help Indian farmers whose yields were chronically below expectations because the crops were taking more nutrient from the soil than was being provided by organic fertilisers alone. Supplementing the traditional organic fertilisers with chemical fertilisers rectified this and helped to stabilise the farming system practised by smallholder soybean and wheat farmers in the Madhya Pradesh state.

Australia provided the opposite scenario for examination—farming systems based almost exclusively on chemical fertilisers. It was found that Australia lacked sufficient understanding of the role that organic fertilisers could play in better managing soil nutrition. When the ACIAR team implemented improved organic fertiliser application—in trials on the Darling Downs—they were surprised to find that modifications made to their source of organic fertiliser, feedlot manure, led to decreased nitrous oxide emissions from the soil.

The modification was to add urban green waste to the manure—opening up the possibility of resolving two waste issues. The green waste increased the carbon component which locks nitrogen into soils.

The research has since delivered an



PARTNER COUNTRY

India

PROJECT DESCRIPTION: LWR/2002/032: Integrated manure nutrient management in soybean–wheat cropping systems on vertisol soils in Madhya Pradesh and Queensland

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(Opposite page) Indian Institute of Soil Science senior scientist Dr Sammi Reddy (left) and former ACIAR research program manager Dr Christian Roth.

Indian and Australian scientists visit a demonstration plot where farmyard manure has been integrated into the integrated nutrient management package to grow soybean.



improved soil-management strategy capable of closing the yield-gap in a sustainable way in India, and in Australia, helping lessen their contribution to climate change.

Underlying all these gains is a better understanding of soil fertility and the impacts that managing this natural resource have on food production, the environment and the economy of farming communities.

Coming together for this ACIAR project was the prestigious Indian Institute of Soil Science (IISS), the University of Queensland and the Queensland Department of Natural Resources and Water (NRW). Partnering the soil scientists was a highly respected farmer-support non-government organisation (NGO), the Bharatiya Agro Industries Foundation (BAIF).

Dr Christian Roth, previously research

program manager with ACIAR, says that traditionally, Madhya Pradesh's smallholders use manure to fertilise their crops but that not enough of this organic material is available to achieve maximum soybean and wheat productivity. "We knew at the outset there was going to be a need to add inorganic fertilisers," he says. "The problem with that approach is that you need to know which particular nutrients are missing in the soil."

IISS senior scientist Dr K. Sammi Reddy says Madhya Pradesh's soils are vertisols—black, well-structured soils of volcanic origin, but with 30% or more clay content—which crack and shrink during the dry season and swell during the monsoon.

Smallholders grow soybean during the monsoon season, contributing to a harvest

that accounts for 75% of India's total soybean production. A wheat crop follows, grown mostly on soil-trapped moisture. Although cropping is undertaken on areas of just two to 20 hectares, these smallholders are important food producers for India.

Dr Reddy says that despite farmers' efforts to fertilise their crops, these farming systems are nonetheless in "negative nutrient balance"—crops are taking more nutrients from the soil than are being returned by the application of manure.

In response, the scientists joined forces with farmers to run trials that diagnosed the soil's nutrient deficiencies, down to individual micronutrients. These on-farm experiments identified deficiencies in phosphorus, sulfur and zinc, in addition to the nitrogen deficiency that farmers already knew about.

"We also analysed farmyard manure pits in different villages and found that the method used to produce manure leads to the loss of nutrients," Dr Reddy says. "At stake is about 40% of nitrogen, 23% of phosphorus and 36% of potassium put into the pits as organic materials such as animal dung, household refuse and ash."

Between the low manure application rate, the nutrient loss during composting and the depleted soils, average soybean yields are just 1.2 tonnes a hectare—half to a third of the yield potential, according to crop simulation and field experiments.

INTEGRATED NUTRIENT MANAGEMENT

To close this yield-gap, scientists set about looking for a fertiliser regime that could remediate soil fertility without causing harm to either the environment or the farms' economic sustainability, given world-wide volatility in input costs, such as fertiliser and energy.

The solution involved combining the farmyard manure with an inorganic fertiliser selected to supply the missing nutrients, especially sulfur and zinc. Because the approach combines organic and inorganic treatments, scientists refer to it as integrated nutrient management (INM).

"It wasn't just about telling farmers you need to fertilise, it was about the need to target the missing nutrients in a sustainable way," Dr Roth says. "You can get a big response simply by providing the missing nutrients."

On-farm trials were undertaken to compare the performance of various fertiliser treatments and determine the optimum rate of application. These succeeded in nearly doubling average soybean yields with three different fertiliser regimes.

Biological fertiliser improves outlook for rice farmers

Among ACIAR efforts directed at improving soil-management practices, a project in Vietnam has demonstrated it is possible for rice growers to use less environmentally harmful forms of fertiliser while improving crop performance and reducing farm costs.

A new biofertiliser technology has been developed by Vietnamese partners and the University of Sydney as part of an ACIAR project headed by Professor Nguyen Thanh Hien in Vietnam and Professor Ivan Kennedy in Australia. The innovation was achieved by combining lower inputs of urea and phosphorus fertiliser with specific microorganisms that increase the amount of nutrients available to plants. The new 'inoculant biofertiliser' is called BioGro.

Research and field experiments with several hundred rice farmers in northern and southern Vietnam found that when the microorganisms are present in a crop's root zones, seedlings in rice paddies inoculated with BioGro require at least 50% less fertiliser than non-inoculated plants.

"The norm in Vietnam is about 100 kilograms of nitrogen fertiliser per hectare," Professor Kennedy says. "With the cost of this input roughly tripling in the past two years—largely as a result of the volatility of oil prices—the development of BioGro has the potential to help alleviate rural poverty and reduce hardship for some of Vietnam's 30 million farmers."

Farmers also report that the inoculated plants are tougher and more resistant to fungi and insects, while scientists see potential to mitigate negative environmental impacts associated with fertiliser use.

"Excess nitrogen from fertilisers enters the environment, pollutes water and accelerates global warming through the production of nitrous oxide," Professor Kennedy says.

Since the project's completion in 2008 it has attracted the World Bank's attention, receiving a US\$200,000 award from its Global Development Marketplace. The award was shared by Dr Phan Thi Cong from the Institute

of Agricultural Sciences for Southern Vietnam in Ho Chi Minh City and Professor Ivan Kennedy and Dr Michael Rose from the University of Sydney.

The World Bank award aims to scale up project outcomes to reach more farmers. A parent company is expected to franchise provincial factories in Vietnam, providing them with the mother culture to produce BioGro. A viable supply chain is also being created to link the factory with farmers.

A key component of this ongoing activity involves technology and skills transfer. The University of Sydney's Dr Michael Rose is continuing his former association with the project as an AusAID Youth Ambassador, helping to ensure quality control of the microorganism cultures. During 2009, two young Vietnamese graduates will join him in Sydney, funded by AusAID's Australian Leadership Awards Fellowships, to learn these sophisticated quality-control techniques.

The winning recipients in 2008 of the World Bank's competitive grant program, the Global Development Marketplace, including Professor Ivan Kennedy (second from left) and Dr Phan Thi Cong (fourth from left).



While 100% inorganic fertiliser yielded 2.1 t/ha, similar yields (2.2 t/ha) were obtained with just 50% of the recommended rate of inorganic fertiliser combined with 5 t/ha of farmyard manure. The further use of *Rhizobium* inoculation also proved beneficial, yielding 2.3 t/ha. Economic analysis found that integrated nutrient management produced the highest net returns (13,457 rupees a hectare) and benefit-to-cost ratio (1.28) to the farmer.

With technical solutions on hand, the project next faced its second, more daunting challenge. With agriculture the mainstay of Madhya Pradesh's economic life, about 71% of the state's 60 million people are directly engaged in agriculture. Reaching all the farmers needing assistance with their soybean and wheat crops seemed an insurmountable problem, but one that ACIAR was determined to tackle from the outset with a project designed to facilitate extension.

"Experience tells us that often research organisations are not the best placed to ensure knowledge generated by research is actually

adopted on farms," Dr Roth says. "The novel element in this project is that ACIAR broadened the partnership to include an NGO that could extract the greatest extension benefit from farmer participation in the R&D trials."

The NGO selected for the project was BAIF, one of India's larger community-based organisations specialising in creating self-employment opportunities for rural families.

Despite the best intentions, Dr Roth says trials and field days in the first year tended towards traditional academic approaches. These came unstuck when confronted by farmers who deal not with single productivity issues but holistic field realities. Indian and Australian scientists alike look back and recall that the academic approach simply did not work.

"To their credit, the scientists were more than willing to analyse what went wrong and fix it—that became the turning point," Dr Roth says.

Dr Reddy says a method was identified to run field trials in participatory ways that promote extension to farmers. Called the 'mother-baby trial' (MBT) method, Dr Reddy's

commitment to its implementation saw him attend an MBT training course in 2006 at the International Rice Research Institute in the Philippines.

He says the 'mother trial' is the initial researcher-driven trial undertaken on-farm to generate statistically robust data. In the next phase, the most promising treatments are selected and with the technical assistance of BAIF, these smaller, 'baby' trials are replicated by the farmers on their own farms. Baby trials serve to generate more data while allowing farmers to experience, choose and refine which treatment best suit their needs.

The crucial role played by BAIF was to provide the capacity to run high-quality baby trials on a scale that stunned Australia's project leader, Dr Neal Menzies.

"BAIF said they could run baby trials on 100 different farms—and we were happy for them to try—but I did not believe they could achieve that many. They actually got 95 baby trial results in one season, which is a stunning effort. It really is a remarkable demonstration of what an



A compost pit prepared by farmers from the village of Rangai as part of the integrated nutrient management project.

original participating villages. However, India is not the only beneficiary.

AUSTRALIAN BREAKTHROUGH

Dr Menzies says there is an Australian component to this project relating to agricultural uses of manure from livestock feedlots, particularly on the Darling Downs in Queensland. It was formulated to take advantage of IISS expertise in the re-use of organic waste in agriculture. Dr Menzies says Indian expertise exceeds anything available in Australia, where organic waste mostly ends up in landfill.

Dr Ram Dalal from Queensland's NRW explains that in Australia about one million tonnes of feedlot manure is generated a year, more than half of it in Queensland. Although some of this manure is used as fertiliser for cropping, the practice was running into problems.

"What we found is that farmers were using 20 to 50 t/ha," Dr Dalal says. "That creates problems of high nitrate and phosphorus levels in soils, which can cause a pollution hazard for groundwater, rivers and even the Great Barrier Reef. Additionally, up to 10% of nitrogen is lost as a greenhouse gas—nitrous oxide—that is 298 times more potent a threat to climate than carbon dioxide."

The scientists wanted to reduce the rate of nutrient release from the manure and decided to mix it with a carbon-rich but nitrogen-poor material to tie up free nitrogen in the soil. They selected green waste compost—the material produced by city councils from managing parks and pruning trees. Australia-wide each year, three million tonnes of green waste is generated and disposed of in landfill, Dr Dalal says.

In a surprise discovery, the mix of manure and green compost was found to reduce emissions of nitrous oxide by up to 60%.

Given that 80% of nitrous oxide is produced from agriculture, even a 50% reduction of agricultural emissions would stand to make a substantial difference as agricultural science faces its greatest challenge ever: doubling food production from the same amount of land while reducing environmental impacts.

"There is a real need to understand nitrogen and learn to use it as efficiently as possible," Dr Menzies says. "The work we did on this project was directed at finding solutions for precisely this challenge."

Dr Roth says he is delighted with the outcome. "ACIAR is always happy when we have such potentially large impacts," he says. "Given the real breakthrough we saw in India, it is then extra special to demonstrate a reciprocal benefit to Australia." ■

effective outreach group they are."

Farmers from the villages of Sanchi, Rangai and Kamapar who took part in the ACIAR project report predominantly good experiences from their interaction with the IISS–BAIF team. Of seven farmers contacted, all intend to continue with the fertiliser treatment. "Integrated nutrient management has shown very good results and production has increased considerably," says Mr Ranjeet Verma, who farms about eight hectares in Sanchi.

BENEFITS NOT ONLY IN SOIL NUTRITION

On the extension front, each farmer reports actively helping others improve soil nutrition, something Ms Sanjay Verma of Rangai says takes place primarily through discussions—"the sharing of views"—among farmers. All report seeing changes in their village as a result.

"There is an increase in technical know-how regarding agricultural practices and an understanding of the importance of micronutrients," Mr Ranjeet Verma says. "So in the village we are experiencing increased production."

However, when listing benefits not a single farmer restricts the list to soil fertility. Mr Ram Manohar Verma cites the availability of improved varieties with the formation of a seedbank in Rangai village; other farmers talk about improved pesticide application or the availability of manure through structures at the village level.

"When farmers see a field, they see a whole lot of problems and are not just focused on the one issue targeted by the research project," Dr Roth says. "So another project impact

made possible by the closer contact between researchers and farmers was a broadening-out of inquiry."

This resulted in solutions to recurrent waterlogging of the soybean crop and a method of preparing and storing manure that avoids nutrient loss.

The enthusiasm farmers have expressed for the research partnership has amazed the scientists who have come to view this response as the project's most spectacular outcome.

"For me, I'm a boffin," Dr Menzies says. "I work in a laboratory. So seeing all these social and cultural dynamics in the research and development system that is helping smallholders—that is something special. If extension efforts continue then this is a project that could potentially have huge impacts."

BAIF's Dr Somnath Roy says farmers are keen to continue with the project and he would like to see Madhya Pradesh's smallholders receive ongoing support: "Madhya Pradesh is a state with 11 agro-climatic zones and each requires at least one chance to get to know the technology in a farmer-friendly way."

With BAIF keen to continue disseminating the integrated nutrient management message, the organisation is seeking operating funds from its own donor base, which includes state and national governments. To help BAIF shore up its case for integrated nutrient management, ACIAR provided additional funding in 2009 for a different district to run a further 100 baby trials.

With the technical side of the project at an end, the scientists and ACIAR are quietly confident that ultimately this is a project with the potential to have impacts well beyond the

COULD COMPOST BE A DISEASE BREAKER?

An innovative soil nutrient program utilising compost is showing potential for sustainable disease control on Indonesian cocoa farms

BY BRAD COLLIS

In South Sulawesi, Indonesia, composting organic waste from cocoa-farming activities is becoming an important new source of soil nutrients, plus a profitable business for some smallholder farmers.

The composting initiative developed by the principal buyer of the region's cocoa, Mars, is an example of the new ideas that are coming out of the AusAID-funded SADI initiative.

SADI—the Smallholder Agribusiness Development Initiative—is a new approach to lifting smallholder farming from subsistence levels to a more business-oriented agricultural economy. It is a partnership between a wide range of research providers, including ACIAR.

Mars started the composting initiative three years ago to help lift the productivity of its smallholder suppliers by improving their soils without the burden of costly (and sometimes difficult to obtain) chemical fertilisers.

Now the success of the program and the support shown by farmers is turning attention to the actual science of composting and the effect that soil condition has on the incidence and severity of disease.

In recent years cocoa production has been hit hard by the combined effects of pod borer (CPB, *Conopomorpha cramerella*), vascular-streak dieback (VSD, caused by the basidiomycete *Oncobasidium theobromae*), Phytophthora pod rot (PPR) and stem canker (caused by the oomycete *Phytophthora palmivora*), and declining soil fertility.

SADI partners are now keen to see if initiatives like the Mars compost program, which can lift soil fertility, can also diminish the impact of disease.

Further development and understanding of the relationship between soil health and disease would add an important scientific basis to the empirical work already done by Mars.

To date, Mars has undertaken extensive trials to develop appropriate processes and 'recipes', and portable composting machinery suitable for on-farm use. Added to this (in line with the SADI objectives) has been the development of a business model based around compost as a saleable product as well as a resource.

Some 39 farmers or farmer groups now have

the mulcher/cocoa pod chopper developed by Mars engineers, producing about 12 tonnes a month of nutrient-rich compost from vegetative waste that was previously burned. The compost is prepared to specific biochemical specifications with the addition of a microorganism product made by a company in Bali.

Technical director for PT Mars Symbioscience Indonesia, Mr Agus Samil, explained that soil tests by Hasanuddin University in Makassar had shown long-term use of chemical fertilisers alone had depleted many farm soils of organic matter. Further, the Indonesian Government was limiting its fertiliser subsidies, making chemical fertilisers more expensive and potentially harder to obtain. Nutrient-poor soils loomed as a potentially serious production constraint for farmers.

In response to this Mars started looking at the possibility of large-scale composting, given the high volume of leaf matter, prunings and pod husks generated in cocoa farming.

After an initial feasibility study in 2005, the company built a small compost-processing factory in Lara, South Sulawesi. The plan at the time was to collect organic waste in a truck fitted with a large mulcher. The company began to introduce the concept of compost to its farmers, teaching them how to prepare organic waste for bagging and collection by the mobile unit. However, after the first year of operation some fundamental obstacles had emerged, such as the proximity of fields (and organic waste) to roads.

"It became clear that the composting needed to be done onsite by the farmers themselves," Mr Samil said. "So we brought in eight small, simple, pod-chopping machines from the Philippines and Vietnam.

"After testing with farmers we found the capacity, durability and safety of the machines needed to be improved, so we had our Mars engineers make some modifications to turn them into improved, high-capacity, portable mulchers for farmers to use."

The units proved so effective that Mars decided to construct a composting business model around them. Farmers or farmer groups with a composting machine produce what they need and sell the rest—supplying their



PHOTO: BRAD COLLIS

Cocoa farmer Mr Muhammad Nur has built up a commercial composting business turning prunings and other garden waste into a valuable soil-conditioning product. He uses a portable mechanical composter designed by Mars engineers.

own fertiliser needs plus creating an income-earning product.

A key selling point for everyone—producers and buyers—are the results from a demonstration site comparing productivity from trees growing on 100% chemical fertiliser (urea), a 40:60 mix of compost and chemical, and 100% compost.

After two years of trials, compost continues to be the most productive source of soil nutrients.

One of the early adopters of composting, farmer Mohammed Nur, said that since switching to compost in 2005 his yields had increased from 200 kilograms of cocoa to 300 kg, or 1.5 tonnes per hectare. ■

PROGRESS IN RESTORING COASTAL AGRICULTURE

Crop failures on tsunami-affected agricultural land in Aceh, Indonesia, spurs ACIAR to get Indonesian and Australian scientists to work together to help Acehnese farmers rehabilitate their land

BY GAVIN TINNING*

The 2004 tsunami saw the low-lying agricultural land of Indonesia's Nanggroe Aceh Darussalam (Aceh) Province inundated with seawater, sand and mud. The seawater raised soil salinity levels and the sediment filled in irrigation and drainage channels, making food production difficult for local farmers. To return the land to sustainable agricultural production, ACIAR provided scientific support to help smallholders remediate their land.

With ACIAR support, the NSW Department of Primary Industries (DPI) and Indonesian Ministry of Agriculture have been working with Aceh's agricultural extension staff and coastal farmers to restore annual cropping on 40,000 hectares of formerly productive farmland.

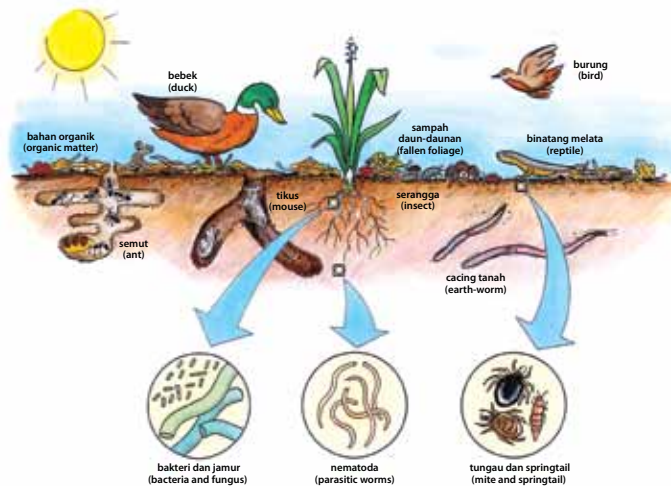
The work is part of a cluster of ACIAR-funded projects that have been addressing the problems caused to agriculture and fisheries by the tsunami.

To address crop failure and low yields, the project developed and demonstrated to farmers viable onsite soil-management practices to restore food production. The demonstration of successful cropping was one of the most important steps in convincing farmers that their land could be productive again.

PRACTICAL OUTCOMES

When the project began, team members found very little information on how to rehabilitate tsunami-affected land. As a result they have developed a practical guide for governments, non-government organisations and communities that may in future have to respond to a tsunami event or major storm surge that inundates coastal areas with seawater.

A practical guide to restoring agriculture after a tsunami, is one of the major outputs of the project. It outlines the main issues that confronted agricultural communities after the tsunami in Aceh and how these were assessed and managed. Chapters included in the guide cover repairing the drainage and irrigation structure, managing the range of different sediment types deposited by the tsunami, soil salinity, restoring farming and capacity building. The guide is currently only available on the internet in English.



A page from the soil biology booklet illustrating the diversity of organisms that contribute to soil biology.

For more information on the soil biology booklet please contact Rebecca Lines-Kelly, rebecca.lines-kelly@dpi.nsw.gov.au, 02 6626 1319, or download the booklet (from July onwards) from www.dpi.nsw.gov.au/research/projects/06P302



Farmers and extension staff in Aceh discuss an early draft of the soil biology booklet.

PARTNER COUNTRY: Indonesia

PROJECT DESCRIPTIONS:

SMCN/2005/118: Restoration of annual cropping in tsunami-affected areas of Nanggroe Aceh Darussalam Province, Indonesia; SMCN/2005/075: Integrated soil and crop management for rehabilitation of vegetable production in the tsunami-affected areas of Nanggroe Aceh Darussalam Province, Indonesia

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In developing the guide the project team worked with Acehnese farmers to obtain detailed information about the effects of salt water and sediment on their fields and the physical destruction caused by the tsunami.

Conversely, farmers participating in field meetings were particularly interested in understanding the biology of their soils. This interest also prompted the NSW DPI together with Indonesian project partners to develop a soil biology booklet in Bahasa Indonesian (the national language of Indonesia). Early drafts were well received by farmers as the booklet illustrated the interaction of organisms and provided advice on how to improve the health of an agricultural soil. Farmers contributed greatly to the

development of the booklet, identifying the type of information that could help them improve their soils and providing descriptions of insects and other organisms present in their soils.

Copies of the soil biology booklet will be distributed to district extension staff in Aceh as a teaching tool and it will be available on the NSW DPI Aceh project website (www.dpi.nsw.gov.au/research/projects/06P302) from July. The English-language guide, *A practical guide to restoring agriculture after a tsunami*, can be downloaded now from this website. ■

*Gavin Tinning, from the NSW Department of Primary Industries, is the project manager for the ACIAR cropping project in tsunami-affected Aceh.

HARVESTABLE HEDGEROWS ENCOURAGE EROSION CHANGE



The farmer cooperators greatly value the innovation of varied and mixed planting on their plots. Traditionally, monocropping has been practised on individual farm plots.



A cooperator-farmer and some of his sons working on one of the 'improved farming practice' farms.



A farmer-friendly approach to conservation agriculture is helping villagers on the Philippines island of Bohol reduce soil erosion and increase incomes



A budding pineapple 'flower' growing within a vegetated strip.

BY ROBIN TAYLOR

Income-earning crops such as pineapple and bananas are being grown in hedgerows adjacent to the main crops—such as cassava and corn—as a creative form of 'money-making erosion control' in the mountainous interior of Bohol Island in the Philippines.

It is hoped that the use of plants, which can generate extra income as well as stabilise the landscape, will be a decisive factor in the island's farmers embracing conservation farming techniques that are being demonstrated in an ACIAR-supported project.

The project—'Evaluation and adoption of improved farming practices on soil and water resources'—is in line with ACIAR's Philippines program on farmer-based land and water resource management for profitable and sustainable agriculture. It is an important component of a cluster of projects managed by Dr Gamini Keerthisinghe, from ACIAR's Soil Management and Crop Nutrition Program, which are specifically focused on increasing agricultural productivity on fragile sloping lands.

The demonstration of improved ways to both farm and stabilise the landscape follows earlier ACIAR work that mapped out the extent of the land degradation and the poverty it has inflicted in the island's hinterland.

The Australian leader of the initial and follow-up projects, Professor John Bavor from the University of Western Sydney, says the task was to identify the main factors contributing to land degradation, and then to work with local farmers to determine alternative practices that will improve their landscape and their economic circumstances.

"A key objective of the project is to quantify, demonstrate and provide examples to farmers of the farm-level economic benefits that can be realised by implementing selected best management practices for soil, water and crop management in affected areas," he says.

Professor Bavor says most of the damage was being done by up-and-down cultivation on slopes, continuous planting of nutrient-depleting crops such as corn and cassava, and extensive cultivation of steep upland soils.



PARTNER COUNTRY

The Philippines

PROJECT DESCRIPTION: SMCN/2004/078:

Evaluation and adoption of improved farming practices on soil and water resources, Bohol Island, the Philippines

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CASE STUDY: Early adopter breaks debt shackle

Alberto Tado is a farmer participating in ACIAR's project site in Sierra Bullones, within Bohol's Inabanga watershed. The municipality has about 4,800 households and about 5,000 people engaged in farming.

Before the project started Mr Tado's annual income from rice, eggplant, squash, cowpeas and melon, on about 0.5 hectares, was 16,000 Philippine pesos (PhP) (about A\$500).

His farm was selected as an ACIAR project demonstration site to improve its productivity and soil conditions. Mr Tado is managing the site for the project, adopting best farming practices for crop, soil and water management. For comparison, farmer participants at other unimproved sites use only traditional farming and land-management practices.

Mr Tado has received onsite training in soil and water conservation technologies, soil analysis, farm journal planning and farm record keeping. Advice has also been provided on how to broaden his cropping options, such as with other vegetables.

The Philippines Bureau of Soils and Water

Management, the International Centre for Research in Agroforestry and local government bodies have also introduced alternative income-raising activities utilising food-processing techniques, accelerated compost preparation, vermicomposting and vermiculture. These new initiatives have been introduced through meetings and hands-on training workshops with the local community.

In the first cropping season, from January to August 2008, Mr Tado planted eggplant, squash, sweet pepper, mango and cowpeas. After just his first harvest his commitment to the project was rewarded. The income from his eggplant crop alone was PhP 31,000 (A\$1,000), which gave him the opportunity to free his coconut plantation from debt. This was a significant achievement as the family plantation had been in debt for years.

As well as the income from his vegetable crops, Mr Tado anticipates an additional income from pineapples planted in hedgerows, which will be harvested in two years. His experience has served as an impressive model for other farmers.

The unavailability of mechanised equipment requires that 'best farming practice' recommendations must be achievable with only hand and draft-animal labour sources – the local caribou are very hard-working.

ACIAR's research program manager for soil management and crop nutrition, Dr Gamini Keerthisinghe, says entrenched practices such as this require a flexible approach to resolve the problem in a way that encourages farmer involvement.

"There is no standard recipe for making farming sustainable on marginal lands. We have to look at what the current practices are and what sort of management practices best suited to the local conditions we can introduce to optimise the efficient use of available resources to increase productivity," Dr Keerthisinghe says.

"It is important that intensification of agricultural productivity does not come at the

expense of degradation of natural resources. However, one of the challenges is to identify practices that conserve the resources and provide additional farmer income.

"Introducing cash crops as hedgerows to minimise soil erosion and increase overall farm productivity is one example," he says.

In the case of Bohol, high rainfall (2,000 millimetres a year) on steep slopes has created chronic erosion, removing topsoil that was rich in crop nutrients and organic matter. This has resulted in low farm productivity and income.

Shifting cultivation—a farming system where farmers move on from one place to

"There is no standard recipe for making farming sustainable on marginal lands. We have to look at what the current practices are and what sort of management practices best suited to the local conditions we can introduce to optimise the efficient use of available resources to increase productivity."

– Dr Gamini Keerthisinghe

FARMING VIETNAM'S MARGINAL LANDS

Concern for smallholders struggling to farm fragile and degraded marginal lands is a key focus for ACIAR, particularly in its program in Vietnam.

ACIAR research program manager Dr Gamini Keerthisinghe says Australian agricultural science expertise is especially suited to help farmers develop sustainable and profitable land-use practices. Falling into this category is the South Central Coastal region of Vietnam.

"One of the priorities we identified in consultation with Vietnam is a need for strategies to develop this area where the degraded resource base is adversely affecting the lives of the many people who live there who rely on agriculture for their livelihood," Dr Keerthisinghe says.

Smallholders in this coastal region face a harsh environment for food production mainly due to poor sandy soils under water-limiting conditions. This poor resource base pulls rural communities further into poverty as low incomes make critical inputs such as fertilisers and irrigation systems increasingly out of farmers' reach.

There are, however, similarities to Western Australia's sandy soils, making Australian expertise a viable option for helping the region improve farming outcomes.

"ACIAR is looking at what resources are available and how to manage them in ways that sustain profitable and cost-effective production systems," Dr Keerthisinghe says. "We identified that the region has potential to develop agriculture, so it emerged that ACIAR could do something positive for this region."

Development of the region's agricultural potential is being pursued in a number of projects that target crops, livestock and dual-farming systems that incorporate cropping with animal production.

One such initiative—the 'Improving the utilisation of water and soil resources for tree crop production in coastal areas of Vietnam and New South Wales' project—has been running for three years and is due for completion in 2010.

Leading the project in Vietnam is Dr Hoang Minh Tam, director of the Agricultural Science Institute of Vietnam's South Central Coast, who is working with Australian project leader Dr Peter Slavich, of the NSW Department of Primary Industries (DPI).

Dr Tam says the region is the poorest in the country due to the severely dry climate and low-fertility soils. "Most rain falls over three or four months of the year and, during this wet season, can cause flooding and erosion," he says. "In the dry season agriculture is highly dependent on irrigation, which is often in short supply."

Tree crops, such as cashew and mango intercropped with peanuts and cassava, are common and are mostly irrigated with long hand-held hoses. Cashews are also grown in areas where irrigation water is not available. Most farmers use animal manures for fertiliser and in some cases might use inorganic fertilisers for higher-value crops.

Since ACIAR prefers to work in close consultation with farmers and farmer groups, the ACIAR team surveyed 150 farmers from the Ninh Thuan and Binh Dinh provinces about their farming practices. Dr Tam says the survey shows that when it comes to managing natural resources, the farmers have little understanding of crop requirements for nutrients and water, so resource-use efficiency is often low.

He provides the examples of farmers growing high-value crops, such as grapes, who tend to over-fertilise and over-irrigate. This is contaminating groundwater with nitrogen

Rice husk biochar for use as soil amendment in sandy soils.



PARTNER COUNTRY Vietnam

PROJECT DESCRIPTION: SMCN/2003/035:
Improving the utilisation of water and soil resources for tree crop production in coastal areas of Vietnam and New South Wales

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another when the land becomes exhausted—is not a viable option for farmers in this region, mainly due to scarcity of land. Thus farmers are forced to continuously crop the same land, further aggravating the process of soil degradation.

The lateral hedgerows may bring back some stability to the island's farming.

Project leader in the Philippines, Dr Gina Nilo of the Philippines Bureau of Soils and Water Management, says the active participation of local farmers has been encouraged through the establishment of long-term field trials and demonstration sites. She says the demonstration sites using soil traps have clearly

shown how much soil could be saved using hedgerows on sloping lands.

"This illustrates the magnitude of the soil erosion," Dr Keerthisinghe says. "Seeing is believing and farmers are now working together to preserve the land for themselves and for future generations"

Professor Bavor says corn, cassava and vegetables are minor crops compared with rice but could be much stronger economically if it was not for their link with erosion. "So what we are proposing is that by progressively adopting good farming practices that are suitable for these crops in this landscape, the farmers will be able to minimise soil and nutrient losses and

produce an economically and environmentally viable crop."

The project team has carried out baseline and end-of-cropping-season surveys to quantify productivity of crops, input costs, marketable yields, market prices and overall economic returns on all farms within the improved and unimproved sites. The farmer cooperators and the project team have collected case study data, which is being used to guide the team in future cropping periods.

The plight of Bohol Island's upland farmers contrasts starkly with coastal communities where tourism is a substantial industry. Away from the coastal strip, agriculture is the main source of income for about 1.14 million people. ■



Cultivation of mango orchard for inter-row crops. Phu Cat district, Binh Dinh.



Flood irrigation and organic manuring of grapes on sandy soils in Ninh Thuan.

in some areas. Also farmers often dig wells and water the crop whenever they think it is necessary, without considering saving water.

By bringing a variety of scientific skills to bear on the problems facing farmers the ACIAR team was able to identify more profitable and sustainable uses of available resources.

Dr Slavich thinks the sandy soils close to the coast should be used for dryland agriculture because adequate water resources for irrigation are not available. In some of these coastal areas, aquifers are already showing signs of seawater intrusion caused by over-extraction, he says. However, in areas further inland, where access to groundwater and streams improves, the scientists think there is potential to increase yields using irrigation and fertiliser.

Irrigation trials that exploit alternative water-management practices on cashew, mango, groundnut and grape in Binh Dinh and Ninh Thuan provinces show significant potential to improve crop yields compared with traditional practices.

"Although cashews grow well on sandy soils, yields could be increased with inputs of

fertiliser and irrigation from the current 600–700 kilograms per hectare for these 'wild' cashews to 2.5–3 tonnes," Dr Slavich says.

Dr Tam also hopes the project will improve the efficiency of water and nutrient uptake on sandy soil. "It is especially important to reduce nutrient leaching and excessive use of our very limited water resource," he says.

"An important outcome of the project will be changing farmers' perceptions about irrigation. By using drip irrigation instead of flooding we can save water, which allows us to expand production while ensuring high yield and efficient production. It may also mean we can develop strategic irrigation in areas currently not irrigated to lift yields and improve reliability," Dr Tam says.

The Vietnamese team is now working with International Development Enterprises, a non-government organisation (NGO) that is developing an affordable drip irrigation system for farmers. The NSW DPI's Richard Swinton, another team member, says this system has been used successfully in Africa and other Asian countries.

Using similar equipment to that under trial in

Vietnam, an irrigation experiment is also being established on a blueberry orchard at Alstonville, in northern NSW, to evaluate partial irrigation strategies. This site also serves as a training facility for visiting Vietnamese scientists.

NSW DPI team members have developed and delivered irrigation and nutrient management courses to 30 Vietnamese researchers, extension officers and some NGO staff. These courses covered a broad range of issues including soil and soil water characteristics, plant water requirements and scheduling, nutrient balances and managing locally appropriate irrigation systems to efficiently meet crop needs.

Dr Keerthisinghe says this Vietnam project is typical of the ACIAR approach: "When we look at constraints to agricultural production, ACIAR likes to work within a holistic understanding of the farming system. To address the needs of the farmers often we need a multidisciplinary approach that engages skills which cut across the production chain, including markets, to deal with broader questions with system-level complexities."

– ROBIN TAYLOR

Information flows FOR WATER-WISE FARMERS

Water management authorities in the Philippines now have the Australian-made tools to help preserve one of the world's most important resources—clean water

Rice paddies located in the catchment of Laguna de Bay, the Philippines: an example of the types of intense farming enterprises in the area.



BY KELLIE PENFOLD

Fertilisers, herbicides and pesticides have, over the past 50 years, brought about unprecedented levels of food production, helping to feed a growing global population. But they have also created an unexpected danger by polluting the water people rely on for survival.

A need for both food security and clean drinking water has landed agricultural science with a new challenge wherever inputs such as fertilisers, herbicides and pesticides are used near the water sources of populated areas. As climate change brings water security to the forefront of global concerns, two affected nations have joined forces to tackle the agricultural contaminant challenge head on.

Dr Rai Kookana is the CSIRO Land and Water scientist charged with running an ACIAR-funded project that links fruit growers in South Australia's Mount Lofty Ranges with the stewards of the Philippines' most important fresh water source, Laguna de Bay. The aim is to turn the tide in agricultural contaminant management in a densely populated tropical ecosystem shared by farming and urban communities.

Coming to the end of its three years of funding in October 2009, the ACIAR project has seen CSIRO work with the University of the Philippines Los Baños (UPLB) and the Laguna Lake Development Authority (LLDA) to improve water quality in Australia and the Philippines by developing tools and techniques to measure pollutant loads from different sources and monitor water contamination.

Laguna de Bay is the second-largest freshwater lake in South-East Asia, and the Philippines' largest and most important freshwater resource, providing water for more than 13 million people. More than 28,000 fishing families rely on the lake for their income.

The project builds on earlier ACIAR-funded work from 2001 to 2005, in Australia and the Philippines, which worked on minimising the impact of pesticides from agricultural systems and uses measurement techniques refined in the Mount Lofty Ranges in earlier studies.

"The LLDA has a mandate to improve water quality in Laguna de Bay, but before we started this project they were in the dark about the agricultural pollution," Dr Kookana says. "Authorities had no option but to make guesses about the contributions of agricultural pollution to water quality impairment."

The latest research in the Philippines has centred on measuring the nutrient, pesticide and sediment loads being transported from the numerous sub-catchments to Laguna

de Bay, and educating local authorities in measuring water quality and quantity, so lake-water quality modelling can be done with greater accuracy and confidence. This data will lead to greater predictability of farm waste runoff in accordance with weather patterns and farming programs. Dr Kookana says greater understanding of 'hotspots' will lead to appropriate future management and intervention measures on the ground.

DATA COLLECTION

The eastern bay's main water source is the Pagsanjan River, a part of the Pagsanjan–Lumban sub-catchment, which is home to diverse agricultural industries, including large rice and vegetable plantings, which are increasingly the source of agricultural chemicals that make this sub-catchment ideal for sample collection and measurement.

In the second year of the project auto samplers were installed on four sites—covering the four main land uses of rice, vegetable, coconut and pig production—in the Pagsanjan–Lumban sub-catchment. LLDA and UPLB staff were trained in the use and maintenance of the auto samplers and CSIRO hosted two researchers (one each from UPLB and LLDA) in its South Australian quarantine laboratory where they learnt about water analysis and sediment-transport modelling.

"When we first started the project some of the most basic information was missing," Dr Kookana says. "Rainfall records for the selected catchment were non-existent.

"But this was easily overcome when we realised schools could play an important role by installing rainfall gauges and keeping daily rainfall records. The schools' response was astounding and some of their record keeping would put trained scientists to shame." (See page 19.)

Joey Carino is the LLDA's community development division chief and has worked closely with the Australian researchers to engage the lake community in the project.

"This research is showing us the way forward. Before it started we knew there was lots of waste running into the water, but we had little understanding of agricultural waste," Mr Carino says, adding that the cooperative nature of the project has seen community members and authorities "mobilised" on tackling the issue.

"We now have a set of technically correct data that we can show to policy and decision-makers to help preserve a potable water source."

Manila is already experiencing problems with reliable drinking water, much of which,

Keeping the water clean

The largest body of water in the Philippines, Laguna de Bay, is also the nation's most important. It supplies drinking water to about 13 million people, of which 3.5 million live along the shoreline. Laguna de Bay supports much industry, including approximately 28,000 fishing families who depend on the lake for their livelihoods. The Laguna Lake Development Authority (LLDA) says more than 343,829 tonnes of fish are harvested from the open waters each year and another 85,000 tonnes of fish are grown out in aquaculture structures within the lake. The lake also supplies the water requirements of local industry and farming.

One of the greatest challenges is maintaining the health of the lake's water. Waste water and sewerage canals in 61 cities and towns within the region drain into 21 tributary rivers, which all drain into the lake. The polluted waters of Manila Bay also make their way into the lake daily, via the tidal flows from the Pasig River. The result is pollution that can kill fish species and native plants and pose a safety risk to humans. Another challenge is biological pollution—the number of non-native fish species, such as the janitor fish, is rising.

More information: Laguna Lake Development Authority, www.llda.gov.ph

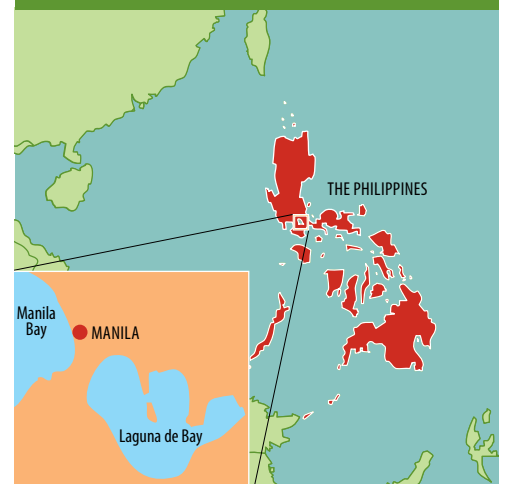
PARTNER COUNTRY

The Philippines

PROJECT DESCRIPTION: SMCN/2004/069:

Minimising agricultural pollution to enhance water quality in Laguna de Bay (the Philippines) and Mount Lofty Ranges (Australia)

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The Laguna de Bay delta.



Mr Carino says, is piped from a river in the Laguna de Bay catchment some distance away. Water sourced from underground is becoming increasingly saline, he says.

“There is an abundance of water in the Philippines, but we have an obligation to make sure it is kept clean to ensure quality water in the future.”

With additional funding from the Crawford Fund and ACIAR, a one-week training course in measuring water quality and water quantity was developed by LLDA, CSIRO and UPLB, and last year it was delivered to more than 50 people, including academics, students, local government staff and community groups in the Philippines.

Study tours by Australian scientists early in the project identified the challenges to water quality in Laguna de Bay. Dr Kookana says it was not uncommon to see a large piggery located on a riverbank with discharge running directly into the water, or the high use of pesticides by rice growers coping with tropical environments.

“It is not as dramatic as it sounds,” Dr Kookana says. “It would be easy to capture the piggery waste in a single outlet and redirect it to a treatment works, once infrastructure is established.”

Farmers in the Philippines, like their counterparts in Australia, have significantly increased their dependence on pesticides in the past three decades. According to LLDA data, between 1977 and 1991 pesticide use in the Philippines rose from 3,738 tonnes annually to 10,773 tonnes, mainly for banana, rice and vegetable production. In the period from 1981

to 1997 pesticide sales in Australia increased from \$166 million to \$1.1 billion according to CSIRO Land and Water.

An important difference, however, is that in Australia most pesticides are used as herbicides (65%), whereas in the Philippines they are used as insecticides (46%), which are highly toxic to fish. However, in recent times fewer pesticides have been used in the Philippines due to

greater awareness of their environmental impacts and greater adoption of alternative and more integrated pest-management measures.

With the measurement and monitoring tools now in place and data banks being established, Dr Kookana says the LLDA can more accurately predict the impact of agricultural activities on water quality and educate land users about the potential outcomes of their choices.

LLDA and UPLB staff are ideal research partners, Dr Kookana says, as they are used to working on international aid projects with strong links to non-government, grassroots organisations, such as the farmer-driven River Councils.

“It’s also been a delight to work with the Filipinos—the workers are confident, there is no hesitation and they will ask questions and share their views. It was easy to find volunteers to train to ensure the samples were correctly taken and stored ready for analysis,” he says.

RUNOFF IN THE MOUNT LOFTY RANGES

Back in Australia, four auto samplers and flow data loggers were installed in 2006 at three sites in the Mount Lofty Ranges’ Lenswood Creek and Charleston sub-catchment.

The Mount Lofty Ranges are home to many intensive, but less varied, agricultural enterprises. An earlier CSIRO project, funded by ACIAR with the National Landcare Program and the

Volunteers in the Laguna de Bay water quality monitoring project standing over a waste water channel from a piggery, which flows directly into one of the bay's catchment rivers.



South Australian Centre for Natural Resource Management, measured and assessed the transport of contaminants from grape, apple and cherry farms into the Onkaparinga River and, subsequently, the Mount Bold reservoir.

The main outcomes from the Mount Lofty project were:

- a detailed dataset of concentrations and loads of pesticide, nutrients and sediment moving to runoff water from apple, cherry and grape production in the area over three years;
- an understanding of the behaviour of these agricultural chemicals moving to runoff water, which can be used to develop a set of recommendations for horticulture to minimise environmental impact from this fruit production;
- a set of reference charts, distributed to Mount Lofty Ranges growers, outlining the risks of pesticides being transported to runoff water as assessed by the CSIRO-developed Pesticide Impact Rating Index (PIRI) software. These charts allow growers to make informed decisions about their choice of pesticides and timing of application with regard to their impact on runoff water; and
- growers in Mount Lofty Ranges can use the management techniques in selecting spraying and nutrient programs for their farms.

The general manager of the Apple and Pear Growers Association of South Australia, Trevor Ranford, says much of the \$60-million-a-year South Australian fruit tree industry is located in the Mount Lofty Ranges and Adelaide Hills—the catchment for Adelaide's drinking water.

"It is important we have knowledge gained on a scientific basis for making sound decisions on natural resource management in our industry," he says.

Mr Ranford says the industry is investigating ways of taking runoff management to the next stage by eliminating the risks posed to drinking water sources, particularly in large rainfall events. Those tools could involve working with the water flow in creating wetland areas to filter the water and developing on-farm strategies to avoid high concentrations of nutrients, pesticides and sediments leaving the farm.

"Our industry understands we need to coexist with the general population and if some of the knowledge we have gained helps the Philippines that's a great outcome. Who knows? We might learn something from them."

Between July 2006 and July 2007 researchers measured the nutrient loads from each of the Mount Lofty sites, recording total nitrogen, total phosphorus and total organic carbon. The grapes site generated the largest loads,



(Top) installation of a rain gauge at a high school in the Laguna de Bay catchment.

(Above) ACIAR research project manager Dr Gamini Keerthisinghe (right) with volunteers from one of the River Councils within the Laguna de Bay catchment following training in how to use the water sampling machine.

followed by cherries, then apples.

Interviews were also carried out with 21 growers covering the four main land uses—apples, pears, cherries and grapes—to get a broader picture of pesticide use in these industries.

A separate assessment of the relative risk of off-site transport of pesticides was made for each of the 21 growers using the CSIRO-developed PIRI. A booklet outlining the findings was produced and supplied to each grower.

This risk information also formed the basis of a series of chemical reference charts, which have been produced and distributed to growers and stakeholders in the region to allow growers to compare the relative risk of off-site transport to surface water of different chemicals in a range of environments representative of those in the Mount Lofty Ranges.

Growers have also expressed interest in being trained in using PIRI, an idea CSIRO has now taken to the Apple and Pear Growers Association of South Australia, who could potentially fund such training. ■

Rain gauges have global appeal

Australians pride themselves on being able to start a conversation based on millimetres of moisture measured in the backyard.

This proclivity has spread to the Philippines, near one of the country's most important water sources, Laguna de Bay, as an offshoot of ACIAR-funded research to minimise agricultural pollution and enhance water quality.

When researchers first started working in the Pagsanjan–Lumban catchment—where much of the area's agricultural production takes place, and much of the water that flows into the Laguna de Bay is caught—accessing correct rainfall data proved one of the project limitations.

However, a simple solution was found. Rain gauges were installed in nine high schools across the catchment. At each school two students and a teacher were trained in rainfall measurement procedures.

Initially a project member travelled monthly to each school to collect the data, but owing to distances and times involved this was not sustainable. A novel solution was found: the data are now sent by text message to the Laguna Lake Development Authority in Calauan.

The figures are stored in a database available to all members of the research team when collating their data and assessing rainfall trends or using runoff models.

To enhance the schools' involvement a teacher's resource booklet was written that suggests how rainfall data could be incorporated into the school curriculum along with experiments about the water cycle and related issues.

Printed in the Philippines, the book is being distributed to 100 schools in the catchment.

Enabling more secure livelihoods in uncertain times



Cam McDonald (left), Monica van Wensveen and Jeff Corfield compare notes during a visit to a farmer who has established a nursery to provide plants and cuttings for a new forage system in the Sulawesi village of Lemoa.

The greatest challenge facing smallholder farmers in eastern Indonesia is the limited range of reliable and profitable farming options for their small plots of land. **Gio Braidotti** reports how an ACIAR-funded project is helping these farmers change the way they manage cattle to reduce the vulnerability of their farms and livelihoods

The farms around SPA village on Sumbawa island are remarkably similar in appearance: three hectares of land divided between three farming activities. Rice is grown on rain-fed lowland fields during the wet season, followed by maize, sweet potato or peanuts. An upland field is planted with tree and cash crops and used to provide feed for cattle. Behind each house in the village is a home garden planted with chilli, fruits and vegetables and home to shelters for cattle, chicken and ducks.

This uniformity comes from central planning—many villages like SPA were created in the 1970s and 1980s as part of the Indonesian Government's transmigration program, which moved people from densely populated islands, such as Java, to less developed areas like Sumbawa.

Of the three land uses, it is cultivation of rice that underpins household food security. It is difficult to overstate the importance of rice in Indonesia and the social impact that it has for farmers. Rice makes up about 40% of Indonesia's total harvested crop area and

accounts for about half of people's caloric and protein intake. On remote Sumbawa, in the absence of farm machinery and with unreliable rainfall, rice cultivation is a labour-intensive and increasingly risk-prone crop. Over the past six years, farmers have struggled to harvest one crop in three.

In these circumstances, cattle are the main safety net, kept so they can be sold when times are tough or for big expenses such as renovations or education. Yet the opportunities for farm profit are greater from cattle than from farming rice. In Sumbawa, as throughout eastern Indonesia, the most common breed is the hardy, small Sapi Bali.

Demand for beef in Indonesia has increased strongly on the back of a growing urban middle class, but Sapi Bali numbers have steadily declined over the past decade as smallholders have had to sell cattle to get through hard times. While imports close the supply gap, smallholders are missing out on a strong market opportunity. However, making the transition from keeping cattle as a form of livelihood insurance to managing cattle as

a productive and profitable small enterprise is not easy. With financial support from an ACIAR-funded project, a team of Indonesian and Australian researchers is helping introduce changes to the management of cattle.

UNDERSTANDING THE FARMING SYSTEM

Before attempting to provide any kind of advice, the joint Indonesian–Australian team sought to better understand the farming system. Leading the Australian team is Dr Shaun Lisson from CSIRO Sustainable Ecosystems. "We needed to understand the key constraints to livestock production across the whole farming system, taking into account biophysical characteristics—like soil, climate, plants and cattle—and socioeconomic factors, such as farmer attitudes, labour availability, input costs and market prices," he says. "With the assistance of farm system models, we then attempted to identify 'best-bet' strategies to address these constraints which farmers could then evaluate in their fields."

Another project team member, CSIRO's Cam McDonald, explains the complexity of issues and choices farmers face. "There are interactions



As well as heading the forage team for the islands of Lombok and Sumbawa, Yusuf Sutaryono feels at ease approaching a Bali cow during an on-farm visit, while CSIRO's cattle expert Cam McDonald looks on.



CSIRO's Monica van Wensveen (left) is part of a follow-up ACIAR project to scale out livestock production innovations to thousands of farmers, assisted by Indonesian graduates Nurlaela (centre) and Sri Wahyuni (front right).

between the household and the farm, as well as flows of inputs and outputs from different production systems, and then there are the impacts of markets and the environment," he says. "In smallholder farming systems these are all closely integrated, making these farms remarkably complex despite their size."

Complicating these issues is the lack of

available land and the importance farmers place on crops as their main income source. "Most arable land is used for cropping and farmers are initially reluctant to plant forages for cows on good land, even if the food crop is not profitable," says Dr Dahlanuddin from the University of Mataram. "Farmers' first priority is to feed their family rather than cattle. That

means there is always an issue with the low quality and availability of feed for cattle, especially during the dry season."

To close the feed deficit, researchers and farmers initially evaluated the use of plants, such as tree legumes used for fencelines, and crop residues that were locally available but not being used to feed cattle. A traditional



PARTNER COUNTRY Indonesia

PROJECT DESCRIPTIONS: AS2/2004/004: Improving smallholder crop–livestock systems in eastern Indonesia; SMAR/2006/096: Scaling-up herd management strategies in crop–livestock systems in Lombok, Indonesia; SMAR/2006/061: Building capacity in the knowledge and adoption of Bali cattle improvement technology in South Sulawesi

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Simple solutions to complex problems

Small farms, such as those around SPA village in Sumbawa, are centred on rice production, reflecting the importance of rice in Indonesian culture. The challenge for the joint Indonesian–Australian project team was to demonstrate how feeding cattle could benefit these farmers, and introduce the means for farmers to profit from this. For the team this meant understanding how the farmers think, and designing practices that were appealing to farmers involved in the project.

The project involved some 60 specialists and was built around the participation of innovative smallholders willing to trial alternative farming practices and build innovation capacity within their local agricultural economies by providing plant nurseries or access to bulls, and sharing technical advice with other farmers. Supporting them was a research network spanning three islands: Sulawesi, Lombok and Sumbawa. The Sulawesi component was headed by Mr Rachmat Rachman of the Assessment Institute for Agricultural Technology (BPTP); while in Nusa

Tenggara Barat (NTB), which encompasses the islands of Lombok and Sumbawa, leadership was provided by Dr Lalu Wirajaswardi (also of BPTP). Also participating were the University of Mataram in Lombok, Hasanuddin University in Sulawesi and Dinas Peternakan, an Indonesian government agency that provides livestock extension and technical services to farmers.

One example of a simple, yet important, innovation introduced by the project team was a new use for the tape measure. Project leader Dr Shaun Lisson, of CSIRO Sustainable Ecosystems, says that buyers were offering farmers a price for their cattle based on an animal's estimated weight. "Unsurprisingly, the buyer's estimate is often less than the farmer's estimate. In the absence of scales, the farmers had no way to ensure a fair price." So the project team introduced a simple way of estimating cattle weight from girth measurement. This approach, used in other parts of Indonesia, is empowering the farmers to bargain for better prices for their cattle.

preference for native grasses meant the farmers had not considered using plants as a feed source for cattle.

“We had difficulty providing feed for cattle, but we did not know we already had good feeds in our village. What we lacked was knowledge,” says Amaq Kusmayadi, a farmer from the village of Mertak on neighbouring Lombok. “It is easy to own an animal, but without information on how to manage it you will lose that animal quickly.”

The project team identified a range of feeding options for farmers to evaluate in an action learning process. This included both local feed resources (crop residues from peanuts, rice and mungbean) and varieties of forage grasses and legumes new to the area. “We learnt that it is not enough to show farmers how to grow forages; we need to show them how to use these plants to get the best out of their animals,” says CSIRO forage expert Jeff Corfield.

Ultimately knowledge became the primary commodity exchanged in the project and Mr Corfield says it is valued as highly as increases

in income among the Indonesian farmers.

The forage work grew into the notion of a ‘feed budget’, in which knowledge about how much to feed each type of animal is leveraged against the availability of feed throughout the year. The result is a planning tool in the form of a feed calendar that helps farmers with seasonal livestock management choices.

“From the early assessments of livestock raising practices, we found that calving was occurring throughout the year, creating haphazard feed requirements,” says Mr Corfield’s Nusa Tenggara Barat (NTB) counterpart, Professor Yusuf Sutaryono from the University of Mataram. “The calendar allows farmers to start thinking about controlling calving dates around the availability of suitable feed for the lactating mothers and weaned calves.”

MORE PRODUCTIVE CATTLE

When the project team first started working in NTB, farmers were locked into low levels of productivity and profitability. They were interested in increasing the productivity of their cattle but not at the expense of land needed for

rice, cash crops or fruit and vegetables. The four years of project activities in the pilot villages have seen farms change dramatically. Not only have the 120 participating farmers allocated and expanded areas for growing forages for feed, they have made a major shift towards managing their cattle for market.

Farmer interviews held before the project commenced indicated that 50% of households did not raise cattle and were therefore exposed to high risk if their rice crop failed. After four years, almost all of the participating farmers are raising cattle and experiencing impacts that they could not have imagined at the start. Most farmers increased household income by 50–300% by selling cattle. Farms that previously could not maintain any cattle are now feeding as many as eight.

Overwhelmingly, the farmers used this extra income to invest in activities likely to reinforce economic gains (such as the building of small farm dams), improve their houses and provide better education for their children.

A profound but less tangible impact has been an increase in confidence and security among the farmers. They are adamant that working together to address problems and opportunities—the action learning approach—has opened new opportunities previously thought unachievable. “Agriculture is so difficult,” Amaq Kusmayadi says. “Participating in this project changed our lives. We compare experiences to improve our understanding and we feel a responsibility to pass on what we have learned to other farmers. It is important for us to share the benefits of this experience.” The farmers feel better equipped to address crises, such as crop failure, without ending up in a debt trap with moneylenders.

FROM HUNDREDS TO THOUSANDS OF FARMERS

ACIAR is already working with CSIRO to build on the successes to date. The original project was conducted on a pilot scale to identify the livestock-management options with the greatest potential to reduce the vulnerability of livelihoods to seasonal crises. CSIRO’s Monica van Wensveen, the Australian coordinator of the two new projects, says the challenge now is one of scale. “We want to reach as many farmers as possible, but need to understand the conditions that make for successful scale-out and adoption of the pilot outcomes.” The new projects funded by ACIAR are allowing the team to develop and evaluate approaches to expanding the local successes to thousands not hundreds of farmers and researching ways of overcoming barriers to adoption. ■



At the SPA village on the island of Sumbawa Australian project leader Dr Shaun Lisson (left) pays an on-farm visit to participating farmer Amaq Sapri.

(Below left and right) tree legumes, grown as fencelines, were not being used by farmers as a feed source for their cattle.



The farmers feel better equipped to address crises, such as crop failure, without ending up in a debt trap with moneylenders.



LOCATION IS THE KEY TO GREENER FISH FARMS

Environmental impact studies of sea-cage aquaculture in tropical waters are helping identify the most appropriate locations and stocking densities to sustainably manage this expanding industry

BY CATHERINE NORWOOD

Fish farming in cages is a lucrative business for otherwise poor coastal communities throughout the Asian tropics and it is an industry that is growing rapidly. The Australian Institute of Marine Science (AIMS) estimates production in Indonesia alone has tripled in just five years.

Until recently, fisheries managers had little information on the environmental impacts of intensive fish farming in tropical waterways and what constitutes sustainable production. Most of the research relates to caged aquaculture in temperate waters, an industry that has been well established for more than 30 years, particularly for salmon.

An ACIAR project involving collaboration between AIMS and the Indonesian Ministry of Marine Affairs and Fisheries is helping South-East Asian fisheries regulators and fish farmers identify the most appropriate levels and locations for production.

Indonesia is one of the largest aquaculture producers in South-East Asia, producing high-value finfish, such as tiger grouper (flowery cod) or mouse grouper (barramundi cod), for live trade to the restaurant markets of Hong Kong and Singapore, where the fish fetch up to \$150 per kilogram. The most intensive sea-cage production sites studied as part of the ACIAR project in Indonesia were in Lampung and South Sulawesi.

AIMS research scientist and ACIAR project leader Dr David McKinnon says one of the major challenges associated with growing fish in sea cages is finding the right place to put the cages. "Once cages are established in a location, a cluster quickly develops in that area, so it is important to ensure sites are suitable before that happens," he says.

"Site selection is the biggest factor in determining commercial viability. Identifying a location that has the optimum water quality, water temperature, oxygen, light and nutrient levels—and that is close to where farm workers live and close to markets or suitable transport for the fish—involves a complex range of decisions and there are many local regulators overseeing the development of aquaculture who may have little experience in this area."

The Cage Aquaculture Decision Support (CADS) tool developed through the ACIAR project allows fisheries managers to classify a site, select the best site from several alternatives, calculate its sustainable holding density and perform a basic economic appraisal.

Dr McKinnon says the project has provided new scientific data on the impact of sea-cage aquaculture, which has been used to adapt production models used in temperate waters to tropical waters. This has included an assessment of nutrient levels due to uneaten food and fish excretions.

He says although many of the risks are the same in temperate and tropical regions, there are substantial differences in the biological process, such as the breakdown of wastes, which occurs more rapidly in tropical waters.

His research has found, for instance, that any 'nutrification' of the environment in tropical waters is highly localised, within only tens of metres of the cages. Uneaten food makes up a significant portion of this nutrient-rich waste. In Indonesia the caged fish are usually fed small 'trash fish', which Dr McKinnon describes as "anything the local fishermen can catch". Once caught, these trash fish are cut up and hand-fed to the fish in the cages.

Australian aquaculture operations use feed pellets specifically formulated for the species being raised, which are better consumed by the fish and result in less waste. "However, Australia's tropical sea-cage aquaculture is currently limited to only one or two operations," Dr McKinnon says. "There is some interest in expanding operations in Western Australia and the CADS tool can be used to help evaluate sites there, as well as in South-East Asia."

The CADS tool has already been widely distributed in Indonesia on CD, with accompanying manuals, and can also be accessed through the internet. Dr McKinnon says tracking through the AIMS website indicates it has already been downloaded by operators and managers in a number of South-East Asian countries outside Indonesia.

He says an important part of the project has been developing networks and expertise within Indonesian organisations, including the Directorate General of Aquaculture, the

PHOTOS: MIKE RIMMER



Visiting a commercial farm in Batam, Indonesia, collaborating scientists (from left) Dr Clarissa Marte and Dr Veronica Alava from the Southeast Asian Fisheries Development Center Aquaculture Department, Iloilo, the Philippines, and Mr Syamsul Akbar, head of the Mariculture Development Centre, Batam, Indonesia.

PARTNER COUNTRY: Indonesia

PROJECT DESCRIPTION: FIS/2003/027: Planning tools for environmentally sustainable tropical finfish cage culture in Indonesia and northern Australia

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Research Institute for Coastal Aquaculture in South Sulawesi, the National Seafarming Development Centre in Lampung, Hasanuddin University and Gadjah Mada University.

In conjunction with another ACIAR project focused on land-based aquaculture, Dr McKinnon is helping to map zones appropriate for offshore and land-based aquaculture in Indonesia, allowing for more coordinated regional management of the industry.

The CADS tool can be downloaded from www.aims.gov.au/docs/research/sustainable-use/tropical-aquaculture/cads-tool.html. ■

Managed forests offer PNG communities new market opportunities

Sustainable harvesting strategies are helping local communities in Papua New Guinea generate income from the forest resources big logging companies leave behind



(Far left) community house constructed from locally milled kwila in the Sogi, PNG, project area.

(Left) the Sogi forest measurement team—Dr Julian Fox and friends—September 2008.

BY CATHERINE NORWOOD

It has been 20 years since the tropical forest near the village of Yalu, in Papua New Guinea's Morobe Province, was logged of its most popular and profitable timber species—kwila, rosewood, walnut, blackbean and red cedar.

Since then the village's 1,500 inhabitants have continued using what remained of the forest for subsistence living: hunting, agriculture, medicines and local building materials.

As is the case with much of the logged, or 'cut-over', forest in PNG, there has been little thought given to the commercial value of the remaining forest and the income it might provide to the community.

Given the rapid increase in the area of cut-over forest in PNG as logging companies move across the country, this is an issue an ACIAR pilot project is addressing, with the PNG government and a number of local communities in the Mamose Region, including the Yalu villagers.

In the past 30 years more than 3.5 million hectares of PNG's 7.5 million ha of accessible forest has been logged, most of it by Malaysian timber companies. The condition of this cut-over forest varies depending on how much

timber was extracted and the quality of the logging.

The ACIAR project is based in the Mamose Region where there are about 550,000 ha of cut-over forest. Australian researchers are working with local communities, the PNG Forest Research Institute and the Village Development Trust to identify forest management strategies and income opportunities that can be marketed as certified sustainably harvested, Fairtrade timber. Communities that have agreed to take part are Sogi in Madang province (20,000 ha), and Yalu (5,000 ha) and Gabensis (2,000 ha) in the Morobe province.

The ACIAR project leader is Professor Rod Keenan from the University of Melbourne's Department of Forest and Ecosystem Science. He says that where forests have been selectively logged, actively managing the remaining cut-over forests has not been a priority for local communities or the government. However, Professor Keenan says, with the right management, many areas of secondary forest could provide an ongoing income through the small-scale harvesting of valuable timber species on 30–50-year cycles, as well as continuing to provide other local needs.

SUSTAINABLE HARVESTING

Professor Keenan says the first step in the pilot project is an inventory of the three selected sites to identify the make-up of the forests—one site is relatively intact forest and two have been heavily logged. He says conducting the inventory is proving to be a challenge in itself.

"The forests in PNG are among the most challenging in the world," Professor Keenan says. "They have a complex structure and species composition, the terrain is difficult and they have complicated systems of tribal or community ownership and management."

Satellite imagery, which is commonly used in forest assessment, is often not suitable for use in PNG because of the dense cloud that regularly blankets much of the country. These images also lack detail on forest composition—information that is needed to evaluate commercial opportunities and sustainable harvesting regimes.

So the researchers are working to correlate information from a number of different sources, including some satellite images combined with radar and physical measurements from more than 250,000 trees in permanent sample plots that have been



PHOTO: JULIAN FOX



Portable sawmilling at Gabensis in Morobe Province, Papua New Guinea.

Conducting an inventory of PNG's secondary forests and charting growth rates is proving challenging, but will help determine sustainable timber yields.

managed by the PNG Forest Research Institute for the past 15 years. The data from the sample plots in particular will help identify the growth rates of various species. This information will underpin sustainable harvesting strategies for both the primary and cut-over forest sites.

Professor Keenan says the emphasis in the pilot project is to evaluate the potential of cut-over forests because they will provide local communities with timber once the remaining accessible areas have been harvested by the logging companies. Many communities are keen to continue timber harvesting but want to receive a greater share of the economic benefits from their forests than they have from larger-scale forest operations.

The trees remaining in the cut-over forests include those too small to have been worth harvesting, as well as lesser-known species. The mix includes kwila, rosewood, walnut, blackbean, red cedar malas, taun, vitex, dillenia, kamerere, terminalia and callophylum. Australian businesses are already offering a 20–40% premium for sustainably harvested, Fairtrade-certified timber from PNG forests, including from lesser-known species. Professor Keenan says there is significant potential to tap into this market.

The success of any harvesting venture will depend on access to roads, which was part of the selection criteria in identifying forest sites for the pilot project. Road access is an ongoing problem in PNG, where some communities are a four-day walk from their closest neighbours. It is one of the reasons why many communities have sold logging rights—because the big timber companies build roads to take out the timber. If they are well constructed the infrastructure remains to the benefit of the whole community, but this has not often been the case.

“An important part of what we’re doing in assessing the tree growth rates, species mix and market opportunities is providing information that communities can use to help them create a business case for investment in better infrastructure,” Professor Keenan says. “It will show them that cut-over forests still have significant value, particularly if they are sustainably managed and harvested.”

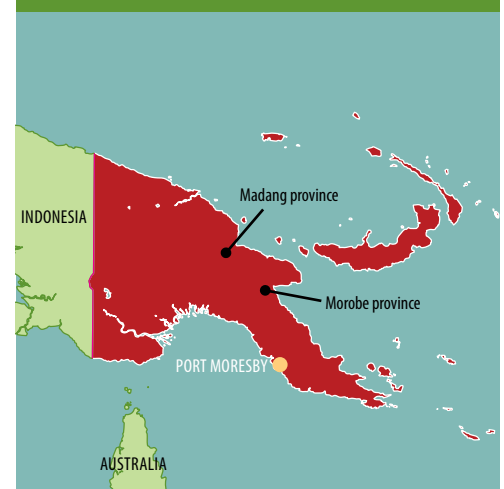
Professor Keenan says information from the project will also be valuable for assessing carbon stocks in forests and supporting potential involvement of communities in reduction in greenhouse gas emissions from deforestation and forest degradation. ■

PARTNER COUNTRY

Papua New Guinea

PROJECT DESCRIPTION: FST/2004/061: Assessment, management and marketing of goods and services from cut-over native forests in Papua New Guinea

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Ten years of soil research

On 28 January, ACIAR celebrated 10 years of partnership with Indonesia's Research Institute for Coastal Aquaculture (RICA), responsible for leading efforts to recover almost 500,000 hectares of tsunami-damaged soils in Aceh. The 10-year partnership has helped the RICA scientists become national leaders in research with the knowledge and expertise to manage soil problems, such as those in Aceh.

RICA, which is based in South Sulawesi, has significantly expanded to now provide a national research service to Indonesia's aquaculture industry through its involvement in collaborative research projects addressing soil remediation, particularly problems associated with acid sulfate soils in aquaculture production.

Soils are just as important to aquaculture as they are to agriculture. However, soil quality and its effect on pond water quality is often ignored or overlooked in aquaculture. During the aquaculture boom of the 1990s many aquaculture ventures in Indonesia failed and losses were often blamed on other, unrelated factors.

Indonesia has approximately 6.7 million hectares of acid sulfate soils in its coastal lowlands. Under natural conditions, acid sulfate soils are harmless and are part of the natural landscape but produce sulfuric acid when they are excavated for shrimp or fish ponds. The acid dissolves metals and permanently alters the chemical and physical properties of the pond soils. Aquaculture ponds constructed in acid sulfate soils quickly degrade because the severe acidity and the dissolved metals are harmful to shrimp and fish.

Dr Gellwyn Yusuf, chairman of the Agency for Marine and Fisheries Research, congratulated researchers

for the successful partnership between RICA, Australia's University of New South Wales (UNSW), Gadjah Mada University and the Centres for Brackishwater Aquaculture Development at Ujung Batee in Aceh and Takalar in South Sulawesi.

Dr Yusuf acknowledged the important roles played by the co-funders of the research, ACIAR and Indonesia's Ministry of Marine Affairs and Fisheries.

"This collaboration provided an opportunity for Indonesian researchers to improve their capability and education and a network for Indonesian and Australian researchers to work together," Dr Yusuf said.

Local project leader Dr Akhmad Mustafa said the ACIAR projects enabled RICA to build expertise and provide a national research service to the aquaculture industry. "The ACIAR projects trained the team in soil assessment and management, soil mapping and pond engineering. With these skills we have been able to conduct research to find solutions to soil-related problems and help farmers improve their production," he said.

The ACIAR projects at RICA also established a national soil-testing laboratory and a land-suitability mapping facility to support the research. A key component of the research has been involving farmers in research.

Mr Akip, a farmer from Pinrang Regency, near RICA, believes the researcher-farmer partnership has benefited farmers directly. "The research was conducted on our farms and we learned a lot about how to identify and manage soil problems to increase production directly from the researchers," he said.

Further afield, the research has helped in recovering land and aquaculture ponds lost in Aceh province following the December



Management of acid sulfate soils can result in profitable returns to farmers.

The Regional Centre for Brackishwater Aquaculture Development (BBAP) facilities in Aceh being rebuilt following the tsunami.

2004 tsunami. The pond remediation methods developed by the project were quickly applied to the farming communities in Aceh after the tsunami damaged more than 20,000 ha of ponds.

"We were able to move quickly to assist the reconstruction effort in Aceh," said Dr Jes Sammut, Australian project leader from UNSW. "The team commenced a program of technical training in April 2005. We trained technical staff, extension officers, researchers, NGOs and farmers in basic soil assessment and management. Our team also helped other programs with pond engineering advice to improve water management. We have also mapped more than 470,000 ha of problem soils in Aceh and offered technical advice on how to manage them.

"The knowledge we have gained from the work in Indonesia is highly relevant to coastal planning and management in Australia," Dr Sammut said. "Over the past 10 years our joint research on acid sulfate soils has raised awareness of the problem in the region and we have been able to influence policy decisions and advise Indonesian and Australian Government agencies on management approaches. A lot of the research in Indonesia has helped us to develop management strategies for coastal development in Australia across several sectors."

During the past 10 years, the ACIAR projects have also supported eight postgraduate and more than 50 honours students from Australian and Indonesian universities.

ACIAR secures increased funding in 2009–10 Budget

ACIAR's appropriation from the Commonwealth Government's 2009-10 Budget will be \$63.6 million, an increase from \$52.33 million in 2008-09.

These additional funds will support the implementation of a new Food Security through Rural Development Initiative, a key component the Australian Government's Official Development Assistance Program 2009-10 Budget allocation.

The Minister for Foreign Affairs, the Hon. Stephen Smith MP, said the initiative's key challenge was to "help lift agricultural productivity in developing countries by working with other donors and research institutions using environmentally sustainable approaches".

"It will also improve rural livelihoods by improving the functioning of markets in ways that increase job opportunities and incomes for the rural poor," Mr Smith said.

In 2009-10 ACIAR will deliver programs that help meet this challenge, including new program thrusts that will:

- safeguard food security and climate change adaptation and mitigation in the rice-based farming systems of South Asia and South-East Asia;
- exploit opportunities for developing high value agricultural, forestry and fisheries products in Pacific island countries; and
- increase financial support to the Consultative Group on International Agricultural Research to help build a stronger CGIAR system.

In addition ACIAR will also be involved in delivering key elements of the Food Security through Rural Development Initiative in Africa. These initiatives will help to strengthen the ability of countries in the Asia-Pacific region and Africa to address food insecurity.



PHOTO: BRAD COLLIS

On the world stage: Peter Core (left) and Dr Mangala Rai, Director-General of the Indian Council of Agricultural Research (ICAR) and Secretary to the Government of India, sign an agreement on marker-assisted wheat breeding.

Farewell to Peter Core

Mr Peter Core, ACIAR's Chief Executive Officer, is retiring on 30 July this year, after seven years leading ACIAR. During that time the Centre has changed in a number of ways.

The revised style of *Partners* is a small reflection of the way the Centre has evolved and grown under Mr Core's leadership.

The history of success of ACIAR projects has continued under Mr Core's tenure. During this period ACIAR has strengthened its focus on delivering impacts that improve the lives of smallholder farmers in the Asia-Pacific region. Many of these success stories have been reported in this magazine.

Under Mr Core's guidance, each year the agency has produced an Annual Operational Plan outlining key priorities for the coming year. He oversaw the change from a Board of Management to the new ACIAR Commission and changes to the Centre's governing legislation. During his time at ACIAR Mr Core has also been involved in shaping and developing the reform processes under way within the CGIAR system.

Mr Core has also overseen ACIAR's move into research on climate change, and has been a passionate advocate of putting into practice measures amongst ACIAR staff to reduce water and electricity



(From left) Australia's Ambassador to Indonesia Mr Bill Farmer, ACIAR stakeholder manager in Indonesia Ms Mirah Nuryati with her Australian Public Service Medal, ACIAR CEO Mr Peter Core, and ACIAR's country manager for Indonesia Mr Julien De Meyer.

consumption (see page 28).

ACIAR wishes Mr Core all the best in retirement and thanks him for his significant contribution and active leadership of the Centre during the past seven years.

ACIAR celebrates 25 years in Indonesia

Australia's Ambassador to Indonesia Mr Bill Farmer hosted a reception on 19 January to mark 25 years of ACIAR's involvement in Indonesia.

Indonesia was one of ACIAR's first partner countries and today is ACIAR's largest partner country, with nearly \$11 million invested this year in projects and training activities.

The reception was attended by key senior Indonesian partners and ACIAR chief executive officer Mr Peter Core.

Speaking at the function, Mr Farmer reflected on the strength of the partnership and its collaborative nature. "Indonesia is ACIAR's largest partner country, reflecting the strong levels of cooperation between our two countries over the past 25 years in the development of agriculture, fisheries and forestry in Indonesia, and in reducing poverty," he said.

Mr Core said ACIAR had a broad partnership in agricultural research with Indonesia, including collaborative programs with the three main ministries—forestry,

fisheries and agriculture—and also across provinces.

"The work ranges from improving export market access for commercial Javanese mangosteen growers, through to improving basic food security for subsistence highland communities in Papua," Mr Core said.

"ACIAR has also supported more than 50 Indonesians to complete postgraduate study in Australia, many of whom are now making a valuable contribution to Indonesia's economic and social development."

Mr Core and Mr Farmer also acknowledged the contribution made by ACIAR stakeholder manager Ms Mirah Nuryati during her 17 years working for ACIAR in Indonesia.

Fellowships pay dividends back home

An evaluation of ACIAR's John Allwright Fellowship (JAF) has revealed a high rate of knowledge transfer upon returning home. Of those fellows surveyed in 2008 almost all said the skills they acquired through their fellowship training were passed on, upon returning home, to those they worked with.

The John Allwright Fellowship scheme provides selected ACIAR project scientists from developing countries with postgraduate

Website accessibility improves

ACIAR's website is now accessible to mobile phone users, with a low-bandwidth template presenting the site in a mobile-compatible format. Visitors to the site can also opt to use this version, compensating for slow internet speeds through the text-only presentation.

The implementation of a mobile-friendly template is just one of a number of improvements to the site, to boost accessibility and make information quicker to access. Other improvements include RSS feeds, printer-friendly pages and enhancements to the site's search engine.

A number of internet visitors use slow connections with low bandwidth. This can mean that websites with photos or graphics are slow to download. To access the text-only version of the ACIAR site users can choose the 'Text only theme' option in the drop-down menu under 'Change website theme (for low-bandwidth version)', which is on the right-hand side of the page, just under the map of the world. Mobile phone users will find that the text-only theme loads automatically on their phones.

Another innovation is a print-friendly template on most website pages. Clicking on the 'Print' option at the top of (most) pages brings up a print-friendly version of that page and speeds up printing.

Next to the print option is an email option, allowing visitors to email a page's address, with a comment. Links to ACIAR pages can also be shared on other sites, such as Twitter and Facebook.

Several pages that are updated regularly, such as 'ACIAR Books Online', 'Current Issues' and 'Media Releases', now have RSS subscription feeds. These allow users to subscribe to these pages and be notified of new updates, such as new publications.

The search engine for the ACIAR website has been enhanced to increase the relevance of pages listed in search returns.

A final improvement is the addition of a Google map feature that shows the location of ACIAR projects and country offices. Using this feature, visitors to the site can find the location of a number of projects and the research being conducted.

ACIAR's website operates as a primary source for people and organisations wanting to find and access information about ACIAR and its work. The website provides comprehensive and accessible information about ACIAR's programs and projects, including country strategies and priorities, project summaries, progress reports, final reports, impact assessments and other evaluation studies.

Research outcomes are published in the form of free, downloadable electronic publications and there is an online shopping facility on the site for purchase in hardcopy. Final reports from completed projects outlining project activities, outcomes and papers arising from projects are now also available online.

You can visit the site at www.aciar.gov.au.



A bank of 48 solar panels was installed on the roof of ACIAR House in Canberra as part of ACIAR's Climate Change Initiative.

training opportunities at Australian universities. Fellows are placed so they take leading roles in the institution where they work and so they can transfer knowledge and skills within those institutions and to professional networks. To date, 149 JAF alumni have completed fellowships.

A survey of all contactable alumni was carried out in 2008 to help evaluate the effectiveness of the scheme. Of the 149 fellows, 111 were contacted. Of those not contacted some 28 fellows no longer live in their home country. Another eight were not contactable and two had died. Of the 111 fellows contacted, 106 responded to the survey, with 75% of respondents still working at the institution at which they commenced their fellowship.

The most encouraging finding was that 99% of fellows are actively transferring knowledge and skills acquired during their studies to other staff at their place of work.

Energy efficiency for ACIAR

ACIAR has maintained a diverse portfolio of projects relating to prediction of seasonal climate variability, adaptation of farming systems and research into greenhouse gas emissions and agricultural mitigation. In 2008-09, ACIAR built on this existing project portfolio by establishing an ACIAR Climate Change Initiative.

Through this initiative ACIAR has cut its annual electricity consumption by more than 25% with a staff commitment to turning lights off when not needed, using fewer, more energy-efficient lights and paying attention to the settings on its air-conditioning system. As part of its ongoing computer system upgrades, ACIAR

has reconfigured its hardware to a more energy-efficient system.

Just before Christmas 2008, ACIAR installed 48 solar panels that are now supplying about 7% of its electricity requirements. This is the third-largest operating solar facility in the ACT.

Under its energy-efficiency initiatives, ACIAR has cut its electricity consumption from 292,391 kWh in 2005-06 to 222,120 kWh in 2007-08, and the prediction is for 2008-09 consumption to be below 2007-08 levels. ACIAR's target is to reduce its gross electricity consumption to below 200,000 kWh in 2009-10.

During a recent visit to ACIAR House the Parliamentary Secretary for International Development Assistance, Mr Bob McMullan, congratulated ACIAR staff on their efforts to reduce electricity consumption and their decision to install the solar facility.

"ACIAR is making a significant contribution to reducing its carbon footprint," Mr McMullan said.

"We don't really have a choice—our energy systems and our consumption must become less carbon intensive," Mr McMullan said. "Without change, our food production systems will be further damaged, challenging our longer-term capacity to produce enough food to feed the world's population, which is predicted to number more than 8.5 billion people by 2050.

Mr McMullan also acknowledged that ACIAR had cut water consumption by two-thirds over the past three years, partly through the use of tank water.

Rainwater tanks were installed in October 2007 and the captured rainfall is used to reduce consumption of non-potable water in operating facilities at ACIAR House.

NEW APPOINTMENTS



Dr John Dixon has been appointed senior adviser, cropping systems and economics. For the past four years John has been director, impacts, targeting and assessment at the International Maize and Wheat Improvement Center (CIMMYT), managing activities on impact assessment, value chains, impact knowledge sharing and systems agronomy. Prior to that, he was senior officer (farming systems) and agricultural management group leader at the Food and Agriculture Organization (FAO) in Rome. John is a PhD graduate of the University of New England and has more than 30 years' developing country

experience, including extensive experience in field crops, economics and natural resource management in Asia (including South Asia) and Africa. John will also take over the regional coordinator (South Asia) role.

Dr Craig Meisner is ACIAR's agricultural research and extension manager in Cambodia for the AusAID-funded Cambodia Agricultural Value Chain Program, designed accelerate growth in the value of agricultural production and smallholder incomes. He worked for CIMMYT for 15 years (until 2005) as a principal scientist and regional coordinator. Since that time he has been working part-time for Cornell University, the International Fertilizer Development Center and as a consultant in agribusiness, economics, agronomy and program review for the UK's Department for International Development, NGOs and several companies. Craig combines research skills and a research management record with significant experience with extension systems/farmer field schools and farmer groups. He has worked with a wide range of crops in rice-based farming systems (including horticultural and field crops) and with nutrients, water and agricultural engineering inputs. Craig has experience in managing USAID and AusAID programs, and has won awards for both his team leadership and research management.



Dr Mirko Stauffacher is ACIAR's new research program manager for land and water resources. After achieving a PhD the Swiss-born Dr Stauffacher worked at the University of Geneva and the United Nations Environment Programme and UN High Commission for Refugees. Mirko migrated to Australia to join CSIRO Land and Water in Canberra. In 2002 he was appointed to the divisional executive as program director for salinity. Since 2005 Mirko has been on secondment to run

programs and a research project portfolio in the combined DAFF/DEWHA natural resource team. Mirko has a strong publication record and experience across hydrology, salinity, geographic information systems, catchment management and exposure to natural resource management and farm level research. Mirko started with ACIAR in December. Dr Stauffacher replaces Dr Christian Roth, who has taken up a position with CSIRO in Brisbane.



Dr Tony McDonald is ACIAR's country manager for Papua New Guinea and Solomon Islands. He has a Bachelor of Social Science from RMIT, a Master of Environmental Planning from the University of Melbourne and a PhD in Natural Resource Management from Charles Sturt University. Tony has more than 17 years' experience contributing to development aid programs, working as a team leader or member implementing activities with government, international NGOs, the private sector and at the local community level for projects in South-East Asia, East and Central Asia and elsewhere. He has worked with a wide range of international organisations such as the World Bank, Asian Development Bank and AusAID and he has managed and implemented a number of large-scale multidisciplinary projects related to natural resource planning, with strong emphasis on participative approaches, institutional strengthening, capacity building and community development.

Dr Peter Horne has moved from working for ACIAR in Indonesia and returned to Canberra as the livestock production system manager. Peter worked on the Smallholder Agribusiness Development Initiative program in Indonesia, and was based in Sulawesi, with his activities focused on building adaptive research capacity in eastern Indonesia to contribute to better linkages between smallholder farmers and markets. Peter has spent most of his career based in Asia involved in agricultural research-for-development, with a particular focus on forages and livestock systems. Peter has also worked as a researcher for the International Center for Tropical Agriculture, CSIRO, North Carolina State University and the University of New England (UNE). He has a PhD in Tropical Agronomy from UNE.



NEW RESEARCH PROGRAMS

CROPPING SYSTEMS AND ECONOMICS

With the increased focus on food security in the Australian aid program, ACIAR has created a new Cropping Systems and Economics (CSE) program. CSE will use collaborative R&D partnerships to improve food security through enhanced productivity and sustainability of field crop farming systems through biophysical and economic research and development. The main responsibility of the program will be developing a proposed program with a food security focus in the Mekong countries and South Asia, and managing a portfolio of research and development projects commissioned by ACIAR in crop improvement, agronomy and farming systems economics and in related areas.

NEW CAMBODIAN PROGRAM

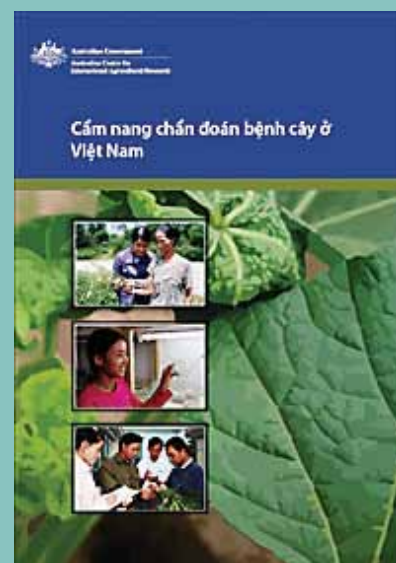
ACIAR is managing the research and extension component of the new five-year, \$42 million AusAID-funded Cambodia Agricultural Value Chain (CAVAC) Program, which commenced in early 2009. CAVAC's goal is to accelerate growth in the value of agricultural production and smallholder incomes in selected provinces (Kampong Thom, Takeo and Kampot) through improved productivity of rice-based farming systems. The ACIAR-managed program component will work in integration with components addressing agribusiness development, water management and irrigation and business enabling environment. Management of the ACIAR component in Cambodia will be undertaken by Dr Craig Meisner, supported by four Cambodian technical specialists (one located in Phnom Penh and the other three in each of the CAVAC target provinces). In addition, the program will engage administrative and support staff.

NEW PUBLICATIONS

CORPORATE PUBLICATIONS

The John Allwright Fellowship scheme: survey report 2008

The John Allwright Fellowship scheme, which enhances the research capabilities of partner-country institutions through postgraduate training of partner-country scientists, is one of ACIAR's key capacity-building activities. In 2008 a survey was carried out of those fellows who have successfully completed their postgraduate qualifications and returned to their home countries, with the results presented in this report.



MONOGRAPHS

Diagnostic manual for plant diseases in Vietnam [Vietnamese translation]

Plant diseases continue to cause significant crop losses in Vietnam and other regions of tropical South-East Asia. Outbreaks of disease of valuable cash crops can have a major impact on small farmers, particularly in localised areas where there are few suitable alternative crops. The accurate diagnosis of the cause of a disease is essential to the success of control measures and for the development of a scientifically sound national database on plant diseases. This translation of the original manual into Vietnamese is designed to help plant pathologists develop basic skills in the diagnosis of the cause of diseases, focusing on fungal diseases of the roots and stems. *Lester W. Burgess, Timothy E. Knight, Len Tesoriero, Hien Thuy Phan, ACIAR Monograph 129a, 210 pp.*

PROJECT FINAL REPORTS

SOUTH-EAST ASIA

Prospects for integrated timber-forage-livestock agroforestry systems for economic diversification in West Timor farming communities

Paul van Nimwegen, David Lloyd and Jerome Vanclay, ACIAR Final Report SMAR/2006/080, www.aciar.gov.au/publication/FR2009-01

Fertilisation-independent formation of embryo, endosperm and pericarp for apomictic hybrid rice

John Bennett, Anna Koltunow, Xinai Zhao, Ming Luo, ACIAR Final Report CIM/2002/106, www.aciar.gov.au/publication/FR2008-48

OUT-OF-PRINT PUBLICATIONS NOW ONLINE

ACIAR is creating electronic versions of a series of out-of-print scientific publications. The publishing program at ACIAR began in the late 1980s, before the spread of the internet and before electronic versions of publications were common. As a result, a number of popular early monographs, proceedings and technical reports sold out of their print runs. With no electronic versions available, these publications have not been accessible, despite continued requests. ACIAR has scanned hardcopy versions of these publications and is now making them available as electronic downloads through its website.

The following publications are now available electronically from the ACIAR website:

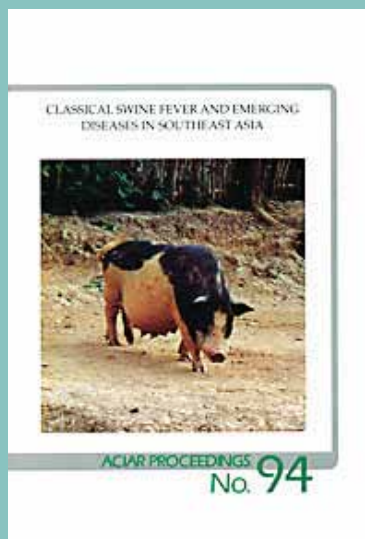
MONOGRAPHS

- Monograph 3 **Grain protectants**
- Monograph 14 **The giant clam: an anatomical and histological atlas**
- Monograph 26 **Biological control of weeds: South-East Asian prospects**
- Monograph 35 **A survey of the subsistence and artisanal fisheries in rural areas of Viti Levu, Fiji**
- Monograph 42 **Global food security: implications for Australia**
- Monograph 43 **Management of soil, nutrition and water in tropical plantation forests**
- Monograph 47 **Partners in the harvest**
- Monograph 48 **Nutrient disorders of sweet potato**
- Monograph 49 **Biological control of weeds: theory and practical application**
- Monograph 57 **Haemorrhagic septicaemia**
- Monograph 60 **Biological control of water hyacinth**
- Monograph 62 **Developing forage technologies with smallholder farmers: how to select the best varieties to offer farmers in South-East Asia**
- Monograph 63 **The food and environment tightrope**
- Monograph 75 **Socio-economic evaluation of the potential for Australian tree species in the Philippines**
- Monograph 88 **Developing forage technologies with smallholder farmers: how to grow, manage and use forages**



PROCEEDINGS

- Proceedings 94 **Classical swine fever and emerging diseases in South-East Asia**



TECHNICAL REPORTS

- Technical report 30 **A review of the biology and management of rodent pests in South-East Asia**

For more information visit the ACIAR website, www.aciar.gov.au/node/9933

NEW PROJECTS

ADP/2005/068	Plausible futures for economic development and structural adjustment—impacts and policy implications for Indonesia and Australia
AH/2008/037	Potential economic impacts of the Varroa bee mite on the pollination of major crops in Papua New Guinea
FST/2006/087	Optimising silvicultural management and productivity of high-quality acacia plantations, especially for sawlogs

ACIAR'S DISTRIBUTION POLICY

ACIAR provides complimentary copies of its publications to developing-country libraries, institutions, researchers and administrators with an involvement in agriculture, and to any scientist involved in an ACIAR project. For enquiries about complimentary copies, please contact ACIAR's Communications Unit, comms@aciarc.gov.au.

For other customers, please use our online ordering facility at www.aciar.gov.au, or direct enquiries to our distributors, National Mailing & Marketing, PO Box 7077, Canberra BC ACT 2610, Australia, phone +61 2 6269 1055, fax +61 2 6260 2770, aciarc@nationalmailing.com.au.

Copies of most publications are available as free downloads from the ACIAR website, www.aciar.gov.au.

ACIAR'S VISION

ACIAR looks to a world where poverty has been reduced and the livelihoods of many improved through more productive and sustainable agriculture emerging from collaborative international research.



The Australian Centre for International Agricultural Research (ACIAR) operates as part of Australia's international development cooperation program, with a mission to achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia. ACIAR commissions collaborative research between Australian and developing-country researchers in areas where Australia has special research competence. It also administers Australia's contribution to the International Agricultural Research Centres.

Back cover: Indonesian girl on the island of Sugal.

PHOTO: DR GIO BRAIDOTTI

Front cover: CARDI research assistant Then Rothmuny planting rice seed in a breeding program.

PHOTO: BRAD COLLIS



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