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IN RESEARCH FOR DEVELOPMENT

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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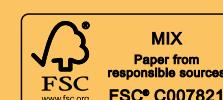
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Effective partners for aid

With the delivery of the Independent Review of Aid Effectiveness to government in April, Australia's aid program is well and truly a national focus. With aid expenditure increasing, those who hold the Government accountable for allocating the Federal Budget—the Australian public—gain a new perspective on the value of their investment in development.

In February this year, Mr Sandy Hollway AO, chair of the aid expenditure review panel, presented the closing speech at the Crawford School Dialogue Conference on the Doubling of Australian Aid. In his address, Mr Hollway stressed the importance of appropriate evaluation methods so that organisations involved in aid—whether they are private companies, educational institutions,

government agencies or non-government organisations (NGOs)—can better target expenditure to achieve the results they are seeking.

A great strength of ACIAR is the value placed by stakeholders on how we conduct assessments of the effectiveness of our programs, primarily through our Impact Assessment Series of publications (see article on page 4). This was apparent through a range of submissions to the review.

ACIAR, however, does not work alone, and the importance of assessing aid delivery mechanisms is also a concern for its partners, which include many NGOs. ACIAR benefits substantially from NGOs extensive experience delivering assistance and building capacity on the ground among communities in need. In turn the NGOs benefit from partnering in ACIAR's research-for-development projects in which agricultural innovations are pioneered, tested and their impacts on rural communities assessed.

In this issue of *Partners*, there are several articles focusing on the synergy and benefits of ACIAR's association with NGOs. World Vision's area development programs in

Vietnam and Thailand (page 6) have resulted in measurable gains in agricultural production through farmers adopting new technologies. Importantly, the collaborative approach has led to adaptation of the research results to suit different farming conditions and locations.

Another story on NGO involvement comes from Papua New Guinea where conflicts surrounding fuelwood availability are being averted (see article on page 9). HOPE Worldwide Papua New Guinea and People's Action for Rural Development are working with smallholder farmers in the highlands to turn a supply-crisis into business opportunities by providing the means to adopt innovative fuelwood production processes and tree species.

The involvement of CARE International and World Vision is also highlighted in a story on the flagship program, Seeds of Life (see article on page 10). Beyond benefiting food security, NGO involvement is helping to establish seed production and storage capacity for local distribution of the improved varieties developed specifically for East Timor. With the project entering a third phase, around 90% of the rural population in East Timor stands to reap rewards.

A story on maize and soybean production and marketing enhancements in Cambodia showcases further work conducted by Care International. Despite its focus on forest conservation, the Maddox Jolie-Pitt Foundation recognises that improving farmers' livelihoods is a prerequisite for protecting Cambodia's biodiversity (see article on page 15).

Also in this issue, we celebrate women with a special edition of ACIAR's Roundup focusing on the achievements of women—from farmers through to senior researchers—working with ACIAR.

In essence, this issue recognises that to be truly effective, ACIAR relies on attracting partners capable of adding further value to our research projects and programs.

ACIAR, however, does not work alone, and the importance of assessing aid delivery mechanisms is also a concern for its partners, which include many non-government organisations (NGOs). ACIAR benefits substantially from NGOs extensive experience delivering assistance and building capacity on the ground among communities in need.

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Aid R&D is a two-way

While there is no 'magic bullet' formula that can be applied to guarantee return on investment for agricultural R&D aid projects, there are some key considerations to support priority setting and effective project development.

Key points:

- A new publication, *Lessons learned from past ACIAR impact assessments, adoption studies and experience, is refining ACIAR's approach to planning, developing and implementing its projects.*
- There is increasing pressure to justify expenditure on overseas aid programs and ACIAR impact assessments indicate positive returns for investment.
- Key elements required for effective program design and delivery are human, management, communication, institution and incentive factors.
- Lessons learned by ACIAR could benefit the wider research community.

BY ALEX BAGNARA

Is foreign aid expenditure a waste of money? It is a blunt question that is increasingly being asked, especially in light of the global financial crisis affecting so many Western economies. Closer to home, the incidences of natural disasters are causing some Australians to ask whether funding overseas aid projects should be deferred to concentrate on national assistance.

"Clearly we are in a time, as collaborators in offshore aid-assistance programs, where it is necessary to justify expenditure and prove that there are substantial returns on investment," says Dr Nick Austin, ACIAR's chief executive officer.

When it comes to ACIAR, impact assessment studies of 90 projects have demonstrated accrued total benefits of a massive \$12.6 billion for a total investment of approximately \$234 million (in 2008 dollar terms). \$11.4 billion worth of benefits are delivered to farmers and economies overseas. The benefits are not just to partner countries. Often overlooked are ACIAR project benefits to Australia.

"It is not enough to state figures and statistics, however," Dr Austin says. "As our programs are put under the microscope, we need to ensure the measures of return are robust and the

expenditure can be reliably justified."

ACIAR plays a specialist role, providing agricultural research and development (R&D) solutions to some of the world's poorest farmers. To ensure these R&D solutions are delivering sustainable outcomes, ACIAR commissions independent impact assessment studies that seek to measure and better understand the benefits realised through this work.

ACIAR has a long history of assessing the impact of its R&D investments and uses these studies to derive valuable lessons for improving the selection, design and delivery of projects. They also serve to demonstrate the value of ACIAR as part of Australia's international development assistance program.

The most recent publication in the ACIAR Impact Assessment Series looks at the past impact assessments and adoption studies. In essence, the review has sought to capture the elements that contribute to a successful project.

Lessons learned from past ACIAR impact assessments, adoption studies and experience was authored by David Pearce, from the Centre for International Economics (CIE), and published by ACIAR in December 2010 (IAS 69).

The review considers lessons learned from impact assessments and adoption studies and includes the results of a qualitative survey of project leaders and ACIAR research program and country managers. It then brings the lessons together in a common framework and considers how the lessons can be applied. It refers to five broad categories of lessons or factors that affect each stage in the project cycle:

- the human factors—the ability of team members, researchers and others involved in a project to communicate and work harmoniously
- management factors—the running and management of the project
- communication factors—covering the approach to communication within the project
- institutional factors—both the institutions within which the project takes place, as well as the broader economy-wide institutional

settings that are likely to influence project adoption and impact

- incentive factors—both the incentive to participate and subsequently disseminate project results and those motivating users to adopt the output from the project.

Throughout the review, Mr Pearce returns to three fundamental points:

- 1 Research outputs will not produce benefits without adoption.
- 2 Potential adopters will not adopt without clear net benefits of doing so.
- 3 The issue of adoption and the incentives facing potential adopters need to be considered at the outset of a project.

Based on various ACIAR adoption studies, factors contributing to or inhibiting adoption of project outputs have been identified and are presented in graph form.

There have been some notable successes. One example uses fruit-fly control projects as a case study to illustrate just how high investment returns can be. It was featured in the November 2008–February 2009 issue of *Partners* and described in the IAS 56, 'A review and impact assessment of ACIAR's fruit-fly research partnerships, 1984–2007'.

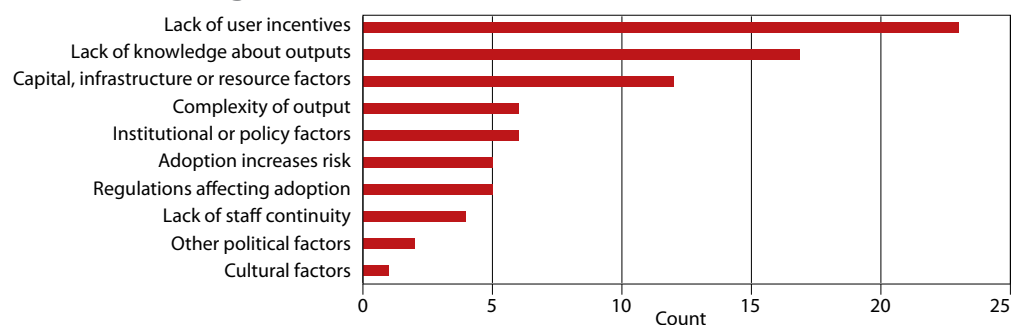
ACIAR–Asian partnerships invested \$50.8 million towards fruit-fly R&D, with ACIAR contributing \$22.9 million. An independent study indicated that the investment in fruit-fly R&D returned benefits to the value of \$258.8 million; that means a return of \$5.10 for every \$1 invested and a remarkable internal rate of return of 33%.

It seems as though the main focus of any questions concerning aid investment is not if there are benefits in spending, but rather what to invest in.

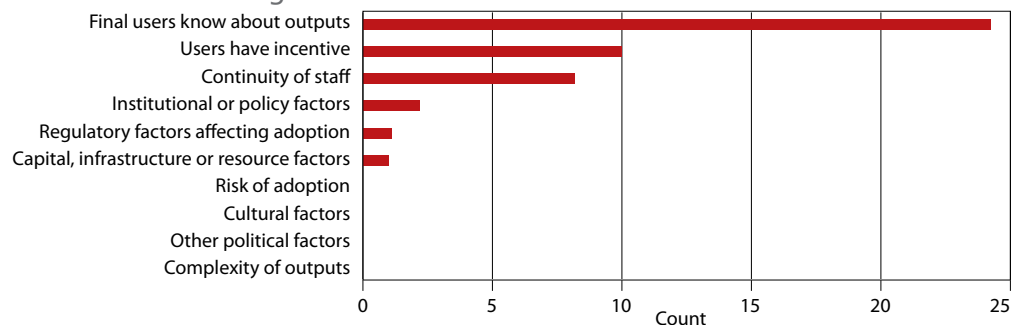
Economist Dr Esther Duflo, of the Massachusetts Institute of Technology (MIT), who has been taking economics into the field to discover the causes of poverty and the means to eradicate it, presented to the TED conference in February 2010. TED is a not-for-profit organisation devoted to "ideas worth spreading", which began in 1984 to bring

journey

Factors inhibiting success



Factors contributing to success



together people from three worlds: technology, entertainment and design. Since then its scope has broadened considerably.

Dr Duflo said at the TED conference that she suspected many audience members had made a donation to the people of Haiti subsequent to the earthquake earlier that year. But, she said, every day 25,000 children die of entirely preventable causes—the equivalent of a Haiti earthquake every eight days. The point Dr Duflo was making was that people are more inclined to give to disaster relief as they can see the tangible benefits of intervention, such as homes and roads being built. It is much more difficult to estimate the return on investment—or indeed if there is a return at all—into alleviation of poverty, or providing food and health security.

Consistent with Mr Pearce's review for ACIAR, Dr Duflo said the biggest myth in development aid is that there is a 'magic bullet' for determining effective delivery mechanisms. A key point she made is that we cannot be

presumptuous about the incentives for aid uptake, and that sometimes the incentives seem to be, in fact, counterintuitive. There is a need for a scientific approach to program delivery in order to gauge its effectiveness.

Dr Duflo was involved in a study in rural India and carried out experiments in more than 100 villages to test how best to promote immunisation. In one-third of the villages, monthly immunisation camps were set up. In another third, parents were given one kilogram of lentils for each child immunised. The remaining villages were used as a control. The incentive of a kilo of lentils produced the highest vaccination rates. She concluded that it is wrong economics to avoid the cost of giving lentils away.

As outlined in Mr Pearce's review, other factors beyond incentives were no doubt critical to the success of the immunisation program, these being the human, management, communication and institutional factors.

Although the variety of ACIAR projects

requires a diverse approach to stimulating uptake, project design should intrinsically consider incentives relating to economic and other factors that motivate users to adopt project outputs.

Incentives are not seen in isolation, however. They are considered as interwoven in the other four categories of factors affecting the project cycle—from problem selection through to project design, team selection, project conduct and management, adoption and linkages. The five key lessons apply at each step in the project cycle.

David Pearce's review states there is a diverse range of information that can be used to derive views about adoption incentives. In order to ascertain appropriate incentives for the uptake of projects, Dr Duflo's approach to experimental design, may well be worth considering in this context.

The review has gone a long way to analyse the elements that contribute to a successful project, however the implications of the study are not just relevant to ACIAR projects. There is potential to consider an experimental research approach in all aspects of social policy design and implementation.

"As ACIAR is in the position of managing a diverse research portfolio in a range of challenging environments in partner countries, sharing the lessons learned by ACIAR is beneficial to members of the wider research community," Dr Austin says.

Given the current climate where programs are so closely scrutinised, the report couldn't have come at a better time. ■

MORE INFORMATION

The publication, 'Lessons learned from past ACIAR impact assessments, adoption studies and experience', can be purchased in hard copy or downloaded for free from:
aciarc.gov.au/publication/IAS69

Esther Duflo's presentation to TED:
http://ted.com/talks/lang/eng/esther_duflo_social_experiments_to_fight_poverty.html

FROM AID TO PROGRESS



World Vision's reach into poor rural communities through its child-sponsorship program is being used to spread agricultural innovations pioneered in ACIAR projects.

BY DR GIO BRAIDOTTI

From the ground up, starting with children—that's World Vision's way when it comes to empowering poor communities. The approach is based on one-on-one engagement, with the non-government organisation (NGO) partnering with individual communities for 15 years to help overcome disadvantage. These engagements take the form of Area Development Programs (ADPs) and are replicated wherever a need exists.

Conny Lenneberg, World Vision Australia's former Director of Policy and Programs, says that any number of specific development projects can be mounted within an ADP depending on need, but common challenges typically involve improving food security, health care, education, sanitation and water.

"The aid is location-based and we work with the most vulnerable and poorest families in a

region," Ms Lenneberg says. "Food is often an issue and that means we routinely engage with agricultural issues."

There is, however, one overarching constant: ADPs address vulnerabilities and aim to improve wellbeing of children who will grow to adulthood during the life of the program. And it is child sponsorship that funds these interventions.

It takes the funding invested in about 3,000 sponsored children to run an ADP, explains Ms Lenneberg.

If viewed from above, World Vision's structure amounts to a worldwide network of alliances between development experts and poor communities, which often face daunting agricultural and natural resource challenges of the kind ACIAR looks to overcome in its research-for-development projects. This makes for an exciting synergy between the two organisations, in which agricultural innovations

pioneered by ACIAR can be adapted, finessed and disseminated by World Vision.

Among those working towards closer ties is ACIAR chief executive officer Dr Nick Austin.

"We have a lot to gain from tapping into NGO community networks that allow rural communities to benefit from agricultural R&D projects," Dr Austin says. "On the flipside, as a research agency, ACIAR can help NGOs by providing them with scientific, evidence-based knowledge to support their advice to people, many of whom are farmers."

To further this kind of partnership, ACIAR and World Vision have agreed to annually review projects under development to identify opportunities to work together. This follows from on-the-ground experience collaborating on several projects in Asia over the past decade.

"From the perspective of World Vision Australia, we recognise that the agricultural and climatic

Participants at an ACIAR training course set rat traps in a rice field in Ha Nam province, Red River Delta, Vietnam.



PHOTO: PETER BROWN, CSIRO

challenges developing-world farmers face are similar to issues that farmers and scientists have addressed in Australia," Ms Lenneberg says.

"This country has an incredible depth and breadth of experience in areas like water scarcity, poor soils, or farming in both tropical and arid conditions. So being able to draw on that Australian experience and adapt it for poor communities is the advantage of partnering with ACIAR."

With 70 World Vision offices spread around the globe—including 27 in Africa, 17 in the Asia-Pacific region and 14 in Latin America—the outreach of World Vision is immense.

"What works in one project gets picked up and socialised into a number of other ADPs, even those funded by other World Vision offices, like Japan or Canada," Ms Lenneberg says. "So World Vision provides a link through which agricultural research can spread to

vulnerable communities quickly."

So the relationship with ACIAR—forged in Australia—now stands to benefit poor rural communities with a truly global reach.

THE TESTING GROUND: VIETNAM AND THAILAND

World Vision Australia and ACIAR first signed an agreement to work collaboratively in 2000. The focus was on six projects embedded in ADPs primarily in Vietnam and Thailand, where the beneficiary population is 10,000 to 50,000 per ADP.

The projects involved farming issues such as rodent control and pest management for rice farmers, the need for better forage options for livestock, and the introduction of dryland rice cultivation to replace transplanted rice in areas experiencing labour and water shortages.

Typical of the ACIAR innovations adopted by World Vision is a pest-management system based on increasing the spacing between rice plants. It works by allowing more sunlight to reach the undergrowth, where it deters pests from breeding. By reducing growth constraints, it becomes possible to obtain higher yields by planting less rice.

Catherine Johnston, who manages World Vision Australia's Asia program, says ACIAR-linked projects have since been formally evaluated.

"There were substantially high results in terms of agricultural production and increased percentage of farmers adopting the new technologies," Ms Johnston says. "So from an evaluation perspective, I think the results were sound."

World Vision Australia's Graham Tardif agrees and says methods such as the rat-control initiative proved popular and were taken up in several other areas in Vietnam ... and not just in World Vision ADPs.

"The method was tested by ACIAR; World Vision introduced it to farmers more widely. But the Vietnamese Government subsequently became very interested in adopting it. It was a partnership that really went well," Mr Tardif says.

Another benefit identified by World Vision is ACIAR's skill in brokering relationships between research organisations. This is further boosted by ACIAR's involvement in building agricultural R&D capacity among in-country partners.

"In Thailand, for instance, the World Vision office and Khon Kaen University have forged a unique partnership in which they work incredibly well together and support each other," Ms Johnston says. "These are relationships first brokered by ACIAR, but the organisations now interact even more outside the project than in it."

STRONGER BONDS BUILD GREATER OUTREACH

Looking to the future, World Vision Australia definitely sees a role for further partnerships with ACIAR. Both are keen to absorb lessons learned in Asia to maximise benefits to farmers.

Stephen Collins, who has overall management for World Vision Australia programs in Vietnam, Thailand and China, thinks the potential to finesse the relationship exists.

"One thing we learned in Thailand is that there can be a grey area between research and extension-ready outcomes," Mr Collins says. "Research results sometimes need to be adapted given different farming conditions and locations. And that creates an ongoing innovation and improvement process that needs to occur within ADPs whenever projects land halfway between research and extension."

This is an interesting arena given that over the years World Vision has expanded its research capacity, especially in food security, climate change, resource management, and in project design and evaluation. Ms Johnston thinks the basis now exists to take the relationship with ACIAR that little bit further.

"In the past, we would have looked to ACIAR to provide the much-needed agricultural research," she says. "But since expanding our own research capacity considerably, there is an opportunity to refine our approach and each other's theory and practice. The idea is to maximise the learnings from all our on-the-ground experience."

One such opportunity comes in the form of better integrating farmer involvement in setting research priorities within ADPs and allowing these priorities to culminate in ACIAR involvement. Currently, ACIAR involvement is negotiated at the national level.

"A sweet potato project in Papua New Guinea is the only one so far that was community-driven," Ms Lenneberg says. "They wanted to develop drought-tolerant varieties. We then took it to ACIAR, whose research managers explored the issue with several of their research partners."

Substantial gains were made through farmer-led field trials and World Vision saw substantial benefits flow from that level of community engagement. World Vision now view it as one of the most successful agricultural research projects they are involved with.

"In discussions with ACIAR they are interested in also adopting that approach and it is something we would love to do more of in the future," Ms Lenneberg says. "So looking ahead, we are quite excited about continuing to work with ACIAR." ■

NGO profile

World Vision is a Christian non-profit and humanitarian organisation working to improve the quality of life of people, especially children, who are marginalised and living in poverty. Established in 1950, the organisation has expertise in areas such as agriculture, micro-enterprise economic assistance, capacity building, and emergency relief and mitigation.

The Area Development Program (ADP) is World Vision's standard program model and is funded by child-sponsorship funds.

Programs are integrated and generally support local economic development and sustainable livelihoods, with a strong focus on health and education. ADPs aim to build the capacity for local people to ultimately undertake their own development.

Vietnam



World Vision Australia supports seven ADPs in Vietnam that reach a beneficiary population of about 400,000 people.

Most are located in mountainous areas where many people belong to ethnic minorities.

In a departure from typical practices, one ADP adopted agricultural practices that were first pioneered in two ACIAR projects. One related to rodent control in rice paddies and the other to soil fertility. Training and support were provided by the ACIAR team to World Vision Vietnam, which then introduced the innovations to ADP farmers.

Leading the rodent-control ACIAR team was Dr Peter Brown from CSIRO Sustainable Ecosystems. His involvement with Vietnam dates back to 1996 and continues to the present, as the initiative went through three stages. These involved first analysing the problems facing farmers and testing solutions with farmer participation before roll out of effective methods to villages.

"Among the effective technology identified in stage one was the community trap-barrier system or CTBS," Dr Brown says. "It involves one farmer planting a rice paddy three weeks before everyone else in the village. That paddy then acts like a vacuum cleaner, attracting rats from surrounding areas. The paddy is surrounded by a plastic fence containing small holes, which lead to multiple live-capture traps. Data

showed this method could improve rice yields in fields located 200 metres from the fence."

The CTBS method is used in combination with a range of community actions (CA) to reduce rodent damage and increase rice yields. These side-by-side methods include synchronised cropping, field sanitation and community rat campaigns to dig out rat burrows in key habitats.

World Vision Vietnam adopted techniques such as CTBS and CA and, with support and training from Dr Brown and his in-country partners, introduced the technologies to farmers beyond the reach of the ACIAR project.

Mr Le Anh Tuan, formerly of World Vision Vietnam and now with the World Bank, has analysed and written about the ACIAR–World Vision experience.

He says 42 experimental sites were set up under the World Vision rodent control project, and 28 experimental and demonstration sites for the soil fertility project. All field sites were managed by farmers, with the support of weekly visits by project staff and quarterly or biannual visits by scientists from local and international collaborating institutions. These include the Institute of Plant Protection, the Institute of Soils and Fertilizers, the Southern Institute of Agricultural Sciences, CSIRO, the International Rice Research Institute, the University of Queensland and the Queensland Department of Natural Resources and Mines.

"The main lesson we draw is that an effective demand-driven collaboration between outside 'change agents' and in-country 'opinion leaders' is needed to transfer innovation," Mr Tuan says.

"We particularly found that the technical support and continuous commitment from researchers played an important role in providing a strong platform for change for the major end users, who are farmers, local government officials and other World Vision staff."

He found that World Vision and local government also played a vital role in some key areas. Of particular value was their ability to:

- promote 'learning by doing' as a way to build capacity
- clarify technical issues
- maintain effective communications among stakeholders
- provide a sense of project ownership among farmers
- embed the work in a broader program of long-term community development.

"This collaborative model using adaptive research provided a good framework of partnership and an active learning alliance between partners," Mr Tuan says.

"Such success stories need to be scaled out, not only to leverage limited financial and human development resources but also to avoid possible traps in the technology transfer process."

Thailand



Maharakham province in north-eastern Thailand is among one of the poorest parts of the country. Dr Gamini

Keerthisinghe, ACIAR's soil management and crop nutrition research program manager, says the major agricultural activity in the area is a single crop of lowland rice, grown under rain-fed conditions during the annual wet season.

"Of the total 57,000 hectares of agricultural land in the target area, almost 92% is planted to rice in the wet season," he says. "Grain yields, however, are below potential yields, mainly due to low soil fertility, salinity and acidity. The second-most important activity is raising cattle for beef production."

By using the rice-growing area before and after cropping, beef production becomes an integral part

of the rice-farming system. Most farming households have two or three head of cattle—a potentially important contributor to family income—but farmers frequently struggle to provide enough feed.

In partnership with Khon Kaen University, World Vision has been actively engaged in raising agricultural productivity and profitability of this vital farming system.

Stephen Collins, country program coordinator at World Vision Australia, says the projects had many different aspects, from introducing new forage options (including plants such as cassava that double as a cash crop), to reducing the weed load on rice production, a problem identified as 'serious' by 94% of surveyed farmers.

"Some of the prime innovations to the dual rice–livestock farms were the introduction of a new

rice variety better suited to dry sowing—RD33," Dr Keerthisinghe says. "It has a shorter maturity time, which provides greater opportunity for farmers to get a second crop in the same season."

To control weeds, row-seeding techniques were tested, with a Thai research institute developing a row-seeding machine.

The third component of the project was training for university students. There are four doing Masters degrees at Khon Kaen University, with the ACIAR project providing the field-research opportunities for the degree.

"There have been some good outcomes for farmers from this project and it has been useful for the ADP staff to learn from the ACIAR-brokered contacts," Mr Collins says. "There are a couple of other ADPs nearby that have also learned a lot from the project."

FUELWOOD TENSIONS SPARK OPPORTUNITY

Over-harvesting of trees in Papua New Guinea is creating a supply crisis for fuelwood, and thus a business opportunity for smallholder farmers.

BY DR GIO BRAIDOTTI

Cooking fires and community celebrations create an ongoing need for firewood in Papua New Guinea. Fuelwood is used by 73% of people in Port Moresby, 96% of people in rural communities and nearly all highlanders. However, this resource is becoming expensive to buy and collection can lead to conflict.

This represents an economic development opportunity for smallholders. With the application of some forestry-management ingenuity, small plots of land are being utilised to meet this high firewood demand.

Rather than use a conventional plantation system, ACIAR is helping PNG establish a 'short-rotation coppicing' (SRC) system in which young tree stems are repeatedly cut to almost ground level to stimulate the regrowth of many new shoots. Coppicing allows wood to be repeatedly harvested, even from young trees, in the manner of a perennial crop.

Project leader, Dr Ian Nuberg from the University of Adelaide, says the aim is to provide PNG with the basis for a sustainable national fuelwood economy that can lift smallholder income and also provide the potential to expand into charcoal production.

"Only landholders who have plenty of land can plant woodlots as they take a long time to grow," Dr Nuberg says. "What we are doing is growing trees like an agricultural crop."

Pilot plantations have been developed using fast-growing species such as eucalypts that are known to coppice well. About 18,000 trees have been planted with the on-ground support of two non-government organisations (NGOs)—HOPE Worldwide Papua New Guinea and People's Action for Rural Development in the highlands.

Staff from both participating NGOs received training in nursery management and raised the project's seedlings in association with PNG's Forest Research Institute (FRI), which was involved in seed sowing and tree establishment.

"We want to make sure that the species used in the SRC system not only grow well but find market acceptance," Dr Nuberg says. "To help us achieve that we surveyed more than 4,000 domestic and industrial fuelwood users and sellers to quantify and describe the nation's fuelwood flows and markets."

Wood and charcoal from different tree species are also being given away, so that people can evaluate them. This includes demonstrations of charcoal stoves at highland cultural events.

"That allows us to understand the value of both the wood and charcoal as a cooking fuel and their market acceptance for broader cultural uses," Dr Nuberg says.

While the study identified tree species that are fuelwood favourites in various regions, not all tree species coppice. In the highlands, for example, the species of choice is the local *Casuarina oligodon*, known as Yar, which is an excellent fuelwood but does not coppice.

"In that situation we are trialling an Indonesian tree, *Casuarina junghuhniana* (nicknamed 'Indoyar'), which is reported to coppice and is suitable for firewood and charcoal."

In total, seven tree species are being trialled in SRC in the highlands, three as highland alley cropping species and seven different species in lowland SRC woodlots. The objective is to establish—in lowland peri-urban areas and highland rural regions—a range of fuelwood production systems as pilot projects.

"Such a system enables the creation of business opportunities to supply a growing fuelwood market, while at the same time providing opportunities to produce other products, including seedlings, poles and fodder," Dr Nuberg says. "So far, the trees are growing very well and the project is being expanded through AusAID funding. ■"



PHOTO: IAN NUBERG

In Papua New Guinea, Dr Ian Nuberg is working with smallholders to use a short-rotation coppicing (SRC) system to meet strong market demand for firewood. In SRC, stems are repeatedly cut to almost ground level to stimulate the regrowth of many new shoots.

PARTNER COUNTRY Papua New Guinea

PROJECT: FST/2006/088: Promoting diverse fuelwood production systems in Papua New Guinea

CONTACT: Dr Ian Nuberg,
ian.nuberg@adelaide.edu.au

NGO profile: HOPE Worldwide

HOPE Worldwide Papua New Guinea is one of 60 affiliates in the Christian NGO, which was founded in 1994. Their mission is to provide medical, educational and social services to underprivileged Papua New Guineans. Staffed by more than 70 Papua New Guineans, the organisation works in partnership with the PNG Government, communities and various international agencies and corporations.

They maintain close relationships with HOPE Worldwide affiliates in Australia and New Zealand, who provide funding support and oversight.

With agriculture a major industry in PNG, the NGO believes training and extension services can assist farming families to achieve both food security and extra income through cash crops. These are considered a necessity in a country where there are formal jobs for only about 15% of school leavers.

NGO profile: People's Action For Rural Development

People's Action For Rural Development Inc is a not-for-profit NGO established and run by Papua New Guineans. It is based in Mount Hagen in the Western Highlands.

The NGO has connections with many local community-based organisations. Apart from the fuelwood project, they run a pig-breeding program and provide microfinance services.

PHOTO: ROB WILLIAMS AND SALLY BOLTON, ACIAR



A farmer brandishes a Hohrae 3 sweetpotato tuber harvested from her fields in the Ossu subdistrict of Viqueque, East Timor. The high-yielding Hohrae 3 variety was extensively trialled by Seeds of Life before its release by the East Timor Ministry of Agriculture and Fisheries in 2007.

A country farms its future

Almost a decade after East Timor's independence struggle, food insecurity remains a major issue. But an Australian-funded research program has been planting the seeds, literally and figuratively, to revive the country's agriculture base and help establish true autonomy.

BY MELISSA BRANAGH-McCONACHY

In a heartbreaking testimony to the futility of human conflict, Australian agronomists arrived in East Timor 11 years ago to find its fields utterly barren. The farmers who had once tended them had long since fled; initially to escape an invasion and then, as the struggle for independence intensified, it was simply too dangerous to return.

The land was left to waste. When independence from Indonesia finally did return after an historic vote in 1999 the impact of ruined agriculture was quickly felt. People were soon starving and along with the disappearance of an estimated one-third of the population went much of the country's farming knowledge. The small amount of seed still stored was soon eaten and some traditional crop varieties subsequently vanished. Irrigation

schemes and agricultural research stations had been destroyed.

ACIAR moved into the area soon after the vote for political independence in 1999 to restore local seed production as the starting point for reviving agriculture. A year later it established Seeds of Life (SoL)—a targeted research, seed production and distribution program that is now entering its next phase.

This third phase, which began in February 2011, will continue to build East Timor's capacity to feed itself. Because economic growth and real independence rely on self-sufficiency, capacity building has been a major program objective and ACIAR personnel at the frontline are confident SoL will deliver on its mission.

However, the young nation still has hurdles

to surmount. Most of its rural population produces insufficient crop staples to last a full 12 months and continues to import 60% of its rice to feed the expanding population, which stands at 1.2 million.

This scenario presents a challenge for the project's next stage, which will build on milestones achieved in SoL's first 10 years, including the development and initial strategic distribution of new plant varieties, and significant food productivity improvements.

FINDING THE SEED

Hundreds of aid organisations have contributed to East Timor's reconstruction over the past decade. An international effort led by the United Nations substantially rebuilt the country's infrastructure and Australia continues



East Timorese women shucking corn grown in the early days of the Seeds of Life program.

PARTNER COUNTRIES

East Timor

PROJECT: CIM2009/049: Seeds of Life 3

CONTACT: Dr Paul Fox,
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PHOTO: ROB WILLIAMS AND SAUL BOUDON, ACIAR

from Indonesia through the Food and Agriculture Organization (FAO), while the ACIAR team imported germplasm from similar agroecological regions using the networks and supplies of the Consultative Group on International Agricultural Research (CGIAR).

Notwithstanding the loss of infrastructure, Dr Piggin and Dr Palmer acknowledged that in East Timor's small cropping area (about 336,000 hectares for 140,000 rural households), agriculture was compromised by unsuitable varieties and reliance on rain.

With hands-on support from non-government organisations (NGOs), including World Vision International and Catholic Relief Services, they yield-tested prospective crop varieties including sweet potato, maize, cassava, peanuts (groundnuts) and irrigated rice.

"SoL 1 had some good outputs," Dr Nesbitt says. "It identified higher-yielding technology options that were better adapted to local conditions including pest, disease and drought tolerance."

GERMINATION

When he arrived in East Timor in 2003, Dr Harry Nesbitt was part of a team that had just completed the difficult task of resurrecting Cambodia's agricultural system.

Having witnessed the destruction wreaked by the Khmer Rouge, Dr Nesbitt expected the situation in East Timor to pale in comparison. Instead, he encountered a country whose controversial history made it a unique crucible for testing the effects of agricultural research on food security. In post-genocide Cambodia, Dr Nesbitt's work introducing farmers to new

varieties, farming methods and crops quickly moved them from hunger to comparative prosperity. After reviewing SoL's progress, he was keen to restore food security in East Timor and recommended the program continue.

Funded jointly by the East Timor MAF, AusAID and ACIAR, SoL 2 began in 2005 with Dr Nesbitt assuming the program coordination role through his post at the University of Western Australia's Centre for Legumes in Mediterranean Agriculture (CLIMA). Plant-breeding specialist Rob Williams, who arrived in East Timor in 2002 to "put food in bowls", was appointed Australian team leader.

Together, they were determined to build on SoL's early achievements to arrest hunger. More than half the rural population was struggling to derive income from one or two hectares. But with food shortages largely attributed to poor agronomy and high crop failure rates—resolvable issues in Dr Nesbitt's eyes—there was potential to develop market-driven systems to support rural development in East Timor.

Among its major achievements, SoL 2 released nine new varieties of five staple crops—maize, sweet potato, cassava, rice and peanuts. Selected from hundreds of hopefuls, the varieties were subjected to rigorous research including field trials before seeds were disseminated to about 10% of farmers across seven districts.

"We import varieties that don't rely on farming inputs, such as fertiliser, because the farmers don't have cash," Dr Nesbitt says. "We're exclusively using non-GM and non-hybrid varieties that are suitable for subsistence farmers and can be adapted to a wide variety of

Maize farmers in an on-farm demonstration trial plot in the Alas subdistrict of Manufahi, East Timor.

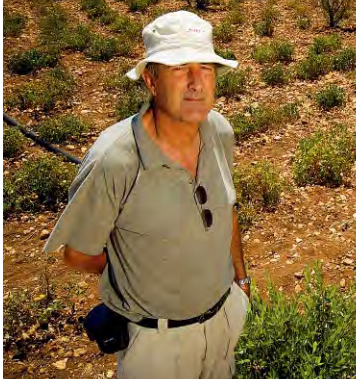
to invest about \$120 million each year on vital redevelopment projects.

But the work most crucial to meeting the nation's food security challenge originated in 2000 under the leadership of Dr Colin Piggin, ACIAR research program manager, and SoL's first on-the-ground project leader, Dr Brian Palmer.

Credited by their successors, Dr Harry Nesbitt and Rob Williams, with "developing the foundation blocks that SoL was built on", Dr Piggin and Dr Palmer worked under challenging conditions, initially in the absence of government order.

Most qualified personnel had left East Timor and the establishment of the Ministry for Agriculture and Fisheries (MAF) was gradual under the new Timorese Government. In the meantime, emergency seed was brought

PHOTO: BRAD COLLIS



Dr Colin Piggin

PHOTO: BRAD COLLIS



Dr Brian Palmer

PHOTO: ROB WILLIAMS AND SALLY BOLTON, ACIAR

Seeds of Life Australian team leader
Rob Williams

PHOTO: ROB WILLIAMS AND SALLY BOLTON, ACIAR

ACIAR's Crop Improvement and
Management Program Manager Paul Fox

agricultural ecosystems.”

Yields have continued to rise, which Dr Nesbitt attributes to seed quality improvements. “On research stations we use high-quality seed and significant culling to produce pure foundation seed, which is sown out and multiplied before the certified seed is distributed,” he says.

“As Timorese farmers grow very small areas of the same crop, cross-fertilisation is an issue for maize. But community-based systems are producing consistent, pure seed on a regular basis to overcome this.”

The European Union-funded CARE International and World Vision are two of the key agencies that distribute seed produced by SoL.

“Over the past couple of years, NGO workers have handed out a couple of hundred grams of seed to about 15,000 farmers—that’s a huge distribution network,” Dr Nesbitt says.

More than 2,500 participating households have grown at least one of the new maize, rice, peanut or sweet potato cultivars, experiencing yield advantages of 23–80% over traditional varieties. Adoption has been rapid: about 70% of the 544 farmers interviewed replanted the following season.

An independent review in early 2009 concluded the second phase of the SoL program was “very successful and directly responsible for food productivity improvements in more than a quarter of East Timor’s [442] villages”.

“The goal is self-sufficiency, therefore entrepreneurialism is beyond the scope of this project, but there are opportunities for farmers to make more money than they have every dreamed of,” Mr Williams says. “The new sweet potato varieties, for example, produce twice the yield, grow in half the time and are highly sought-after in the markets in Dili.”

SoL sweet potato varieties generated the first cash sales ever of farm produce, surplus to subsistence requirements for a number of rural East Timorese.

“Timorese farmers are on the edge of the

poverty line, with an annual income of US\$50, while the average coffee farmer earns about US\$200. But sweet potato farmers can make about US\$1,900 each year, which translates into significant economic and social benefits,” Mr Williams says.

STORING THE SEED

Survey feedback from more than 1,500 households nominated weevil tolerance, taste and yield as the key plant-selection criteria for growers, most of them subsistence farmers who rate eating quality and harvest potential equally.

“Pests and micro-organisms are responsible for a third of the country’s stored grain losses, and weevil damage in sheathed maize can be higher than 60% in some cultivars,” Mr Williams says.

SoL 2 research has proven the effectiveness of storing grain in airtight containers, and CARE International and other donors are providing 44-gallon (200-litre) drums to prevent losses to pests. Early trials also identified two white maize varieties that showed superior weevil tolerance.

SPREADING THE LOVE

A community-based food-production system piloted by CARE International has given SoL ‘wings’ and will be a key component of the project’s third phase.

Under the CARE-sponsored scheme, more than 30 producer groups in two subdistricts have used minimal inputs to multiply one kilogram of seed six-fold, enabling them to grow sufficient food for themselves plus save a surplus from the multiplied seed.

“About 20% of East Timorese farmers are buying seed, so some of the CARE International groups have generated a good income charging farmers a premium for new varieties,” Mr Williams says.

Encouraging producer groups to grow and store seed for local distribution is much more effective than giving the government or SoL responsibility, according to Dr Nesbitt. “The benefits of community-based seed production

are immense and we will adapt and extend the CARE International initiative under SoL 3,” he says.

BUILDING CAPACITY

Building crop research and extension capacity in East Timor’s agricultural sector was SoL 2’s second mission, after increasing on-farm yields.

The team had little to work with when the program started. “Infrastructure was in a bad way,” Mr Williams says. “When the Ministry was established in 2004, it had only six research staff and a budget of about \$1 million.”

Forty MAF researchers (mostly University of Timor-Lorosae agronomy graduates) plus several hundred extension officers have since completed training under SoL 2, and SoL’s mandate to rebuild three agricultural research stations is well under way.

Mr Williams says mentoring has strengthened MAF staff’s ability “to design research programs, and recommend methodologies and varieties to farmers”, while formal computer training has improved statistical analysis within the Ministry.

Crawford Fund sponsorship has enabled SoL to support a University of Western Australia (UWA) PhD student, who will return to East Timor this year, and a Masters graduate, who is now Research Director at MAF. SoL is also backing other postgraduate students at UWA and Indonesian universities.

Literacy has been the only setback. Less than half the East Timorese population can read or write and, according to Dr Nesbitt, language limitations have “held things up” on the training front. English courses are being conducted regularly to tackle the issue and capacity building will continue under SoL 3.

LOOKING AHEAD

Substantially funded by AusAID, the project’s \$25 million third stage will set up a national seed scheme in East Timor, involving the private sector and producers.

SoL currently reaches about 10,000 farming

Seeds of Life

Seeds of Life is funded jointly by East Timor's Ministry of Agriculture and Fisheries (MAF) and the Australian Government through AusAID and ACIAR. The Centre for Legumes in Mediterranean Agriculture (CLIMA) at the University of Western Australia (UWA) is commissioned to coordinate the Australian-funded activities.

SoL 2's non-government organisation (NGO) partners included:

- Ainaro and Manatuto Community Activation Project (AMCAP)
- Austcare
- CARE International
- Catholic Relief Services (CRS)
- Concern Worldwide
- Friends of Luro
- German Technical Cooperation (GTZ)
- Loda
- Oxfam International
- Plan International
- Rai Maran
- United Nations Development Programme
- World Vision.

Seeds of Life achievements since 2000

- In conjunction with the East Timor Ministry for Agriculture and Fisheries (MAF), SoL has released nine new varieties of five staple food crops:
 - maize—Suwan 5, Sele
 - rice—Nakroma
 - peanut—Utamua
 - sweet potato—Hohrae 1, Hohrae 2, Hohrae 3
 - cassava—Ai-luka 2, Ai-luka 4.
- Since 2000, SoL has imported and tested 210 prospective crop varieties.
- More than 2,500 households have grown at least one of the new maize, rice, peanut or sweet potato varieties, with yield increases of 23–80%.
- 70% of participating farmers actively replanted at the first opportunity.
- SoL has been directly responsible for food productivity improvements in 26% of East Timor's 442 villages.
- SoL completed rehabilitation of the MAF Betano Research Station in 2007. Work on the Loes Research Station in Liquica is almost complete and preliminary work on the Darasula Research Station site in Baucau is under way.
- SoL has conducted or supported formal training courses for East Timorese staff, exceeding 1,000 'people training days' each year.

More information is available at seedsoflifetimor.org

Socioeconomic benefits grow from 'Seeds'

Reducing poverty and hunger is the major objective of Seeds of Life, but many East Timorese farmers are realising profits beyond food security.

Baucau district farmer Martina Boavida planted sweet potatoes for household consumption after receiving stems from SoL in 2006.

The mother of seven used cuttings to multiply the new varieties and now has 1.5 ha under crop, generating US\$2,000 each year. The healthy income has transformed lives. "I pay school fees for all my kids, buy them new clothes and have improved their diet since I can now afford beef and chicken," Martina says.

"This success has given me the motivation to work hard every year. Sweet potatoes are good for my family to eat but [the surplus] is easy to sell on the market so we gain in two ways."

Martina's experience is shared by others. A report of economic benefits derived from SoL varieties in 2007–08 indicated some farmers generated income that was predominantly used for food and household materials. SoL researchers believe cash may also be set aside for inputs to increase yields in future years.



PHOTO: ROB WILLIAMS AND SALLY BODIN, ACIAR

Suwan 5 is one of the new maize varieties released in East Timor by Seeds of Life in conjunction with the Ministry of Agriculture and Fisheries.

families, but will target 130,000 households—about 90% of the rural population—under SoL 3.

The population is expected to double within 30 years, but expansion will see seed production active in most of the country's 13 districts over the next five years. Dr Nesbitt believes East Timor can achieve a 30% productivity increase over that period.

"SoL 3 aims to find productive varieties of a wider range of crops including beans for higher protein, potatoes that can be grown in the uplands, wheat, barley, cowpeas and pigeon peas," Dr Nesbitt says. "We will also look for more current crop varieties to reduce risk."

Agronomy improvements associated with the release of new cultivars may further improve yields, and trials will explore fertiliser, plant spacing and weed control using biological methods including cover crops.

ACIAR's Crop Improvement and Management research program manager Paul Fox says introducing forage legumes to the rotation could also support East Timor's cattle and buffalo industry, underpinning a stronger livestock export trade to Indonesia.

SoL 3's formal seed-production program will feed into a community-based system of more than 1,000 producer groups, who will distribute

seed locally, selling the surplus at market.

About 400 MAF officers have been recruited to extend technology and knowledge to farmers, and up to 700 demonstration trials will allow researchers to evaluate on-farm performance against research station results.

Dr Fox says building strong relationships between the MAF and CGIAR centres is also a priority to ensure germplasm flow "after the expats withdraw".

"At the end of SoL 3 we want to see a system driven by farmer demand for seed, not by the Ministry's capability to release seed," Dr Fox says. ■

CASSAVA, CYANIDE AND KONZO DISEASE

A disability caused by a staple food, which leaves people unable or struggling to walk, is potentially devastating to a poor rural community. A sample test kit is helping to reduce this disability throughout the developing world.

BY DR GIO BRAIDOTTI

The staple food for up to a billion people in the tropics has a major health drawback: cassava's edible tubers and leaves contain a potent poison—compounds containing cyanide.

However, the Australian plant chemist Dr J. Howard Bradbury explains that there is a survival advantage to the plant from making these compounds—they repel predators, allowing the plant to thrive in the tropics. Remove the poison, as some US bioscientists did, and the plant becomes weak and ineffective.

The plant is popular, especially in tropical Africa, because it yields well in any conditions and is drought resistant. Its cultivation is spreading, but problems occur when it spreads faster than the food-processing know-how needed to prevent cyanide poisoning.

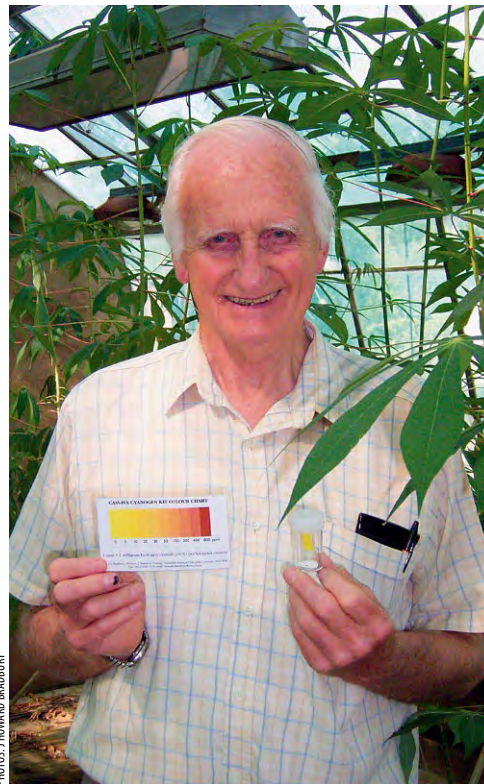
"Frequent consumption of insufficiently processed bitter roots and flour causes paralysis of the legs," Dr Bradbury says. "This disease is called konzo and affects mainly rural children and women of child-bearing age in Africa, with Angola recently becoming the sixth African country affected by konzo."

In the 1980s Dr Bradbury was funded by ACIAR to analyse the tropical root crops of the South Pacific region and he realised then that the cyanogens present in cassava could be a health problem in Africa. Upon retiring from the Australian National University (ANU), he became a visiting fellow and opted to do something about his concerns.

With ACIAR support, at ANU he developed a cyanide-detection kit that requires no advanced laboratory equipment or expertise. The kit provides a colour-coded measure of cyanide levels in cassava roots and flour. It was first made available worldwide in 1996 and can be used by anyone with a high-school level education.

Since then Dr Bradbury has been manufacturing the kits at ANU. Each kit contains enough material to run 100 tests and he gives away about two kits for each one he sells (at a current price of \$450) and uses the money to develop other konzo-prevention technology.

The kit has proven especially popular with plant breeders working in remote locations. It allows them to select for high-performing but low-cyanide cassava varieties—a selection



PHOTOS: HOWARD BRADBURY



In Mozambique, these twin four-year-old boys can no longer walk as a result of konzo.

Dr J. Howard Bradbury at the ANU glasshouse surrounded by cassava plants and holding up the colour chart from the cyanide detection kit he developed to help prevent konzo disease. The ten shades in the chart represent from zero up to 800 parts per million cyanide.

strategy that is known to reduce the risk of paralysis.

Dr Bradbury's kits have been used in this capacity in East Timor since 2006 by the AusAID-funded ACIAR Seeds of Life project, as part of cassava-improvement efforts.

"The kits are made at ANU but are sent out all over the world, including the US, the UK and Latin America where the Amazonian cassava plant originated," he says.

In total, about 750 kits have been distributed in the past 15 years, often to researchers in universities and agricultural institutes. To ensure the technology is available to all who need it, Dr Bradbury has avoided patenting his invention and has published instructions on how to make the kits.

He has also developed the 'wetting method' to lower cyanide levels in cassava flour by up to six times.

In the wetting method, dry flour is placed in a bowl and the level it reaches is marked in the inside of the bowl. Water is added with stirring until the wet flour reaches the mark. The wet flour is then placed in a thin layer on a basket

and left in the shade for five hours or in the sun for two hours to allow hydrogen cyanide gas to escape. The damp flour is cooked in boiling water in the traditional way to make a thick porridge.

"Developing the wetting method was one of the most practical things I've ever done as a chemist," he says. "It is currently undergoing testing in Africa in a particularly badly affected village in the Democratic Republic of Congo."

Urine checks—which use a kit developed by Dr Bradbury to measure thiocyanate levels—indicate that the proportion of children in danger of getting konzo has dropped from 49% to 28% since the adoption of the wetting method by women.

Despite these efforts, Dr Bradbury has no illusions about the underlying cause of konzo.

"When people get konzo, cassava makes up 80% or more of their food intake. If diet were improved they would never get konzo. A shortage of proteins—especially protein that provides the sulfur-containing amino acids needed by the body to clear cyanide—is making people more susceptible." ■



PHOTO: CATHY REID

Mr Ho He, of Samlout village commune, grossed about US\$6,000 from his maize and soybean crops grown on his 11-hectare farm using a range of new technologies introduced through the ACIAR-funded project.

GOOD BUGS, BAD BUGS AND NEW HOPE

Farmers in poor areas of north-western Cambodia are changing their farming practices to increase profits and to establish better systems for the long term.

BY MANDY GYLES

When Mr Ho He from Samlout district in north-western Cambodia found lady beetles in his maize crop he knew they were on his side. He knew they would help control the pests infesting his crop so he could avoid spraying with pesticides and therefore save money. Mr He's healthy crop of maize ultimately yielded well, returning about US\$2,000 solely from Thai stockfeed buyers.

A father of six, Mr He farms 11 hectares in a picturesque region near tropical-forest-covered mountains in an area that was once a Khmer Rouge stronghold. He is one of the farmers who have been testing a range of emerging

innovations such as new maize and soybean varieties, rhizobia to increase legume yields and improve soil fertility, and fertilisers and herbicide treatments. It was through a farmer field school on integrated pest management (IPM), initiated by an ACIAR project, that Mr He learned about the 'good' and 'bad' bugs and better ways of managing pesticides.

The ACIAR project is helping farmers in upland areas to improve and diversify their crops, with a focus on maize and soybeans. The project is led by Professor Bob Martin, Director of the Primary Industries Innovation Centre, a partnership between the University of New England and Industry & Investment NSW.

IMPROVING PEOPLE'S LIVELIHOODS

Taking a key extension role in the ACIAR project are two non-government organisations (NGOs)—the Maddox Jolie-Pitt (MJP) Foundation and CARE International.

The MJP Foundation has a strong focus on forest and wildlife conservation, but is also improving farm productivity so that farmers are more likely to preserve the nearby Samlout Protected Area, one of the region's last significant rainforests.

MJP Foundation chief executive officer Stephan Bogner explained that in 2003, the foundation's focus was exclusively on the conservation of the forest and the endangered

species. "We slowly realised that it was going to be very difficult to protect the green spaces when the villagers themselves didn't have food security, good education opportunities, healthcare services or household income security," Mr Bognar says.

"We've been helping to introduce a diversified agricultural system to around 1,500 farmers. Many are very poor, widowed families with very low incomes, so we are introducing vegetable gardens, poultry, pigs and fishponds. A lot of people here don't know much about farming, so they are not achieving the yields they could be."

Through ACIAR, Australia's vast experience in agriculture, livestock and fisheries could be tapped to provide Cambodia's struggling farmers with best-practice techniques to make the most of their limited resources.

"Cambodia is still emerging from a civil war, so is a young nation and a lot of farming skills disappeared, especially in these isolated communities," Mr Bognar says. "Working with ACIAR has provided a wonderful opportunity to tap into a knowledge bank and bring it back to Cambodia and then scale up and scale out our operations so we can reach a lot more villagers and farmers."

MANAGING PESTS

Australian agronomist Stephanie Belfield has been introducing the concept of IPM to farmers

and extension workers through workshops.

"We've been trying to address the issue of pesticide overuse in Cambodia," Ms Belfield says. "A lot of these pesticides are not good for human health and farmers don't use personal protection equipment, so we cover all these issues through the IPM workshops."

One key message is that spraying early in the season can wipe out beneficial insects, causing crop problems as pest numbers build up catastrophically over time. The result is low production and high input costs.

"IPM workshops have potential for a great impact on the farmers and could be very beneficial to their health and wellbeing, and also to their profitability," she says. "Farmers are very interested in this work and if we can extend the message widely then it could be well adopted."

REACHING CHILDREN AND PARENTS

Project leader Professor Bob Martin is someone who thinks outside the square.

When attending an IPM workshop he thought up a novel way to explain the complex IPM idea. He came up with the idea of writing a storybook to help get across the key messages to schoolchildren.

Fast forward a couple of years, and IPM concepts are now being taught to the local teachers in all five of the MJP Foundation's targeted primary schools, as part of a life-skills

program. The book, 'Jorani and the green vegetable bugs' (written in Khmer and English), has been beautifully illustrated by Professor Martin.

The children undertake a six-day program with various games such as 'Who Am I', and role-play the consequences when all the good bugs are killed and a farmer is over-exposed to pesticides.

As parents and the school community watch the children perform in their colourful costumes, the IPM messages are transferred to farm families more broadly and, importantly, reach the next generation of farmers.

FARMER FIELD SCHOOL

Helping to reach farmers in another region of north-western Cambodia is CARE International, whose rural development program assists some 3,000 farmers around Pailin.

CARE International agricultural adviser Mr Touch Van* has been working on the ACIAR crop production and marketing project. In October 2010 he ran an IPM workshop for farmers growing maize, soybean and mungbean crops.

"At the workshop, when we got to the field, we found a lot of insects and the farmers thought it was a good time to spray because the crop was at the fruiting stage," Mr Van says. "We advised them that a lot of the bugs were actually beneficial, like hoverflies, lady beetles,

PARTNER COUNTRIES

Cambodia

PROJECT: ASEM/2006/130: Enhancing production and marketing of maize and soybean in north-western Cambodia and production of summer crops in north-eastern Australia

CONTACT: Professor Bob Martin, bob.martin@une.edu.au



PHOTO: MANDY GYLES



While their parents watch on, Samlout school children in Cambodia take part in role play during a session on integrated pest management in the life skills program.



PHOTO: CATHERINE REID

Collecting insects at an integrated pest management farmer field school in Pailin, October 2010.

other insects and also spiders. We found a few bad ones as well, but finally we decided not to spray because there were more beneficial bugs.”

He was pleased with what the workshop achieved. “At the beginning the farmers didn’t know what IPM was, or what the good and bad bugs were, or the best way to control them. So they started with very limited knowledge. After our workshop, they told us they understood IPM, they could identify which were the good and the bad bugs, and they knew when to control and not to control them.”

MULTI-FACETED APPROACH

The project, Professor Martin says, has encouraged farmers to diversify their crops and adopt more sustainable practices. “Our surveys show that the farmers in Samlout and Pailin have only been growing crops for the past seven or eight years (the war between the government and the Khmer Rouge only ended in this area in 1998). Around Pailin in particular, there is almost a monoculture of maize because of the strong demand for stockfeed from Thailand.”

Even though the soils are fertile, by growing two maize crops a year the scientists expect soil fertility to decline rapidly. In response, a major focus has been introducing nitrogen-fixing legumes such as soybeans, mungbeans and peanuts. This coincides with efforts to demonstrate the benefit of using rhizobia—soil bacteria that fix nitrogen levels—and fertilisers.

“It’s pleasing to see that the farmers are already taking on the new technologies that

are available, such as the new varieties, the IPM practices and limiting the use of herbicides to control weeds when insufficient labour is available,” Professor Martin says. “But for IPM, the farmers need access to the biological pesticides and they’re not yet widely available.”

Professor Martin has started discussions with potential producers and suppliers of biological pesticides and rhizobia, now that farmers are aware of the benefits of using them. Cool-room storage with temperatures below 18° C is also required to store the rhizobia and soybean seed.

“Climate variability is also a risk and this year, for example, the farmers experienced a number of failed crops in the early wet season. So there is also potential for some conservation cropping practices.”

VALUE OF NGOS

Professor Martin is positive about the benefits of working with NGOs, especially their strong participatory approach. “They are very good at transferring technologies to farming communities,” he says.

“Our whole project design uses the participatory action research approach, so we have engaged with the farms at the outset before we start putting in our trials and demonstrations. This has allowed us to ensure the technologies we demonstrate are relevant to the farmers and will address their needs.”

The NGOs have been assessing the technologies in farmers’ fields and their data show not just the improved yields, but impacts on gross margins. CARE International and the MJP Foundation can now help roll

out the improved technologies to a broader group of farmers.

LOOKING AHEAD

To help spread the new ideas and technologies beyond the areas where the MJP Foundation and CARE International are currently working is the next challenge. Professor Martin says there are four avenues for reaching farmers—through provincial government extension offices, NGOs, the private sector and the education sector.

“They all have different strengths,” he says. “To be successful we need to look at all of the different levels. The ACIAR project has produced a number of hands-on manuals for producing upland crops. These are valuable resources for the public sector extension services, and other extension providers, such as NGOs.”

Since agricultural suppliers reach all the farmers, talks are under way to engage them to transfer technology. “The ones we’ve spoken to are keen to hand out leaflets or booklets with the seed and agricultural products they sell,” he says. “There is a lot of value in getting information out about the safe use of pesticides and having instructions in Khmer on the safe and effective use of the chemicals.”

Professor Martin thinks farmers need access to techniques that improve sustainability. “These include crop rotations, reducing the amount of tillage and adopting conservation agriculture-type principles,” he says. ■

** Touch Van will arrive in Australia in mid-2011 to undertake a PhD at the University of New England as an ACIAR John Allwright Fellow.*



Not the end of the story—members of the soil health team discuss next steps for taro recovery in a farmer's field in Samoa. From left, Tolo Iosefa (taro breeder at University of the South Pacific), Mike Smith (leader of the Soil Health Project) and David Hunter (soil scientist at University of the South Pacific).

Lesson in diversity from Samoa's taro blight

ACIAR was one of the agencies that stepped in to help Samoa rebuild its taro production after it was devastated by a fungal disease in 1993. Samoa's disaster was also a warning for other taro-growing countries, which are now better placed to face pest and disease threats.

BY ANNE MOORHEAD

In 1992, if you were invited to dinner in Samoa you would almost certainly have been served the tasty root taro as part of the meal. That same year, Samoa's taro exports brought some A\$4 million into the country. But just one year later, Samoa's taro was gone, destroyed by a fungal disease called taro leaf blight. All the varieties of taro grown in Samoa proved susceptible and they were wiped out with frightening speed.

Gone was a crop that provided a potato-like root or corm, edible stem, spinach-like leaves, export income and a role in gift-giving and ceremonial activities.

Dr Mary Taylor, who manages the Centre for Pacific Crops and Trees (CePaCT)—the region's genebank, in Fiji—says it was, sadly, a disaster waiting to happen. “We now know that the taro varieties that were growing in

Samoa—and indeed those growing across the Pacific region—have a narrow genetic base,” she says. “In other words, although they may look different, they are all closely related and in this case that meant none of them had any resistance to leaf blight.”

Once leaf blight arrives on an island, it doesn't go away. To recover taro production in Samoa, the only solution was to develop new taro varieties suited to Samoan conditions with leaf blight resistance. The varieties would have to satisfy discerning consumers. And to recover the export market, they also needed traits such as shelf life, which makes them transportable.

ACIAR and AusAID were among the agencies that stepped in to help. Recruited to assist was Tolo Iosefa, a taro breeder at the University of the South Pacific (USP) campus in Samoa, and also a taro farmer. He says the situation needed

a taro-breeding program that could respond quickly to crisis.

“We needed to develop new varieties that had resistance to leaf blight, but that were also acceptable on various other characteristics, such as palatability, yield and tender leaves [which are also eaten],” Mr Iosefa says. “We realised that the best way to do this would be to have taro farmers at the heart of the project, helping to select and evaluate the plants produced by the breeding program.”

So began the Taro Improvement Project, a farmer participatory breeding program managed by Mr Iosefa and supported by AusAID.

The project established a partnership between USP, the Secretariat of the Pacific Community (SPC), Samoa's Ministry of Agriculture and Fisheries, and the farmers of Samoa. All taro farmers in Upolu and Savai'i



PHOTOS: ANNE MODRHEID

Project leaders collaborate. Mike Smith, leader of the Soil Health Project, and Roy Masumdu, leader of the Cleaner Pathways Project, in Samoa.



Staff from the Samoa Ministry of Agriculture and Fisheries prepare taro for export. Here a staff member is shown trimming roots.

were invited to take part, as long they agreed to provide feedback to the project on the performance of the trial varieties.

Over the project's 10 years, more than 100 farmers have been involved and several thousand different taro plants have been evaluated.

Today, taro is back on the menu in Samoa and small-scale exports recently began again. "We have essentially solved the taro leaf blight problem in Samoa," Mr Iosefa says. "We have 100 or more resistant varieties out in the fields."

The breeding program is continuing, now funded by SPC, but the focus is changing to introduce additional traits of value to farmers, such as drought resistance and higher nutritional value.

The crisis in Samoa also provided the impetus to build and consolidate a regional collection of taro genetic resources to support this and other breeding programs in the region. The Taro Genetic Resources: Conservation and Utilization project (TaroGen) began in 1998 and was funded by AusAID.

More than 2,200 different accessions (or samples) of taro were collected from across the Pacific region by the TaroGen project. The next step was to reduce this large number to a more manageable core collection, and this was one of the tasks of an ACIAR-funded project that ran from 1998 to 2001.

"A core collection contains the maximum amount of genetic diversity within the smallest number of samples," Dr Taylor explains. "This makes long-term conservation much more feasible, particularly where resources are limited. And because core collections are well characterised, it also promotes use and exchange."

Tissue samples were sent to the University of Queensland for molecular analysis. This allowed the collection to be reduced to 196 accessions. This core collection is housed at CePaCT.

The results of this painstaking work provided insights into the origins of Pacific taro. According to the DNA analysis, most if not all the taro grown across the Pacific originated in Melanesia, and particularly Papua New Guinea and Solomon Islands.

"Taro would have been carried by canoe eastwards from these islands and gradually introduced across the Pacific region," Dr Taylor says. "But because taro is vegetatively propagated—reproduced from cuttings rather than seeds—there was little opportunity for new varieties to develop. That's why we've ended up with limited diversity."

The solution to the leaf blight problem was to look outside the region for resistance genes—to South-East Asia, which is believed to be a second centre of diversity for taro.

"We crossed our preferred Samoan varieties with varieties from Indonesia and Malaysia that had leaf blight resistance," Mr Iosefa says. "In that way we could keep the traits of our familiar and locally adapted varieties, and integrate disease resistance. It took time and a lot of work, but ultimately it was successful."

The ACIAR-funded project also addressed the need for virus-free plant tissue—a prerequisite for moving germplasm between countries without inadvertently spreading disease. A team based at Queensland University of Technology characterised all known taro viruses and then developed specific tests for each one. Using these tests, the team then carried out virus surveys, testing samples from across the Pacific region to learn about virus distribution. This knowledge and the new virus tests have opened up the way for safe movement of taro germplasm.

Samoa's disaster serves as a warning to other taro-growing countries that have not yet faced leaf blight, including Fiji, Vanuatu, Tonga, the

Cook Islands and Niue. These countries can now arm themselves ahead of a possible outbreak. Fiji in particular is vulnerable as its taro export industry—currently worth about A\$10 million a year—depends on the same varieties that were wiped out in Samoa.

To protect the region's food security, the core collection is available to plant breeders across the Pacific region and beyond.

Samoa learned the hard way, but the effective response to the crisis means that the country is now much less vulnerable to other challenges that may lie ahead.

"Taro is such an important crop here, we need to safeguard it into the future," Mr Iosefa says. "To do that, we'll be keeping diversity in the fields." ■

PARTNER COUNTRIES

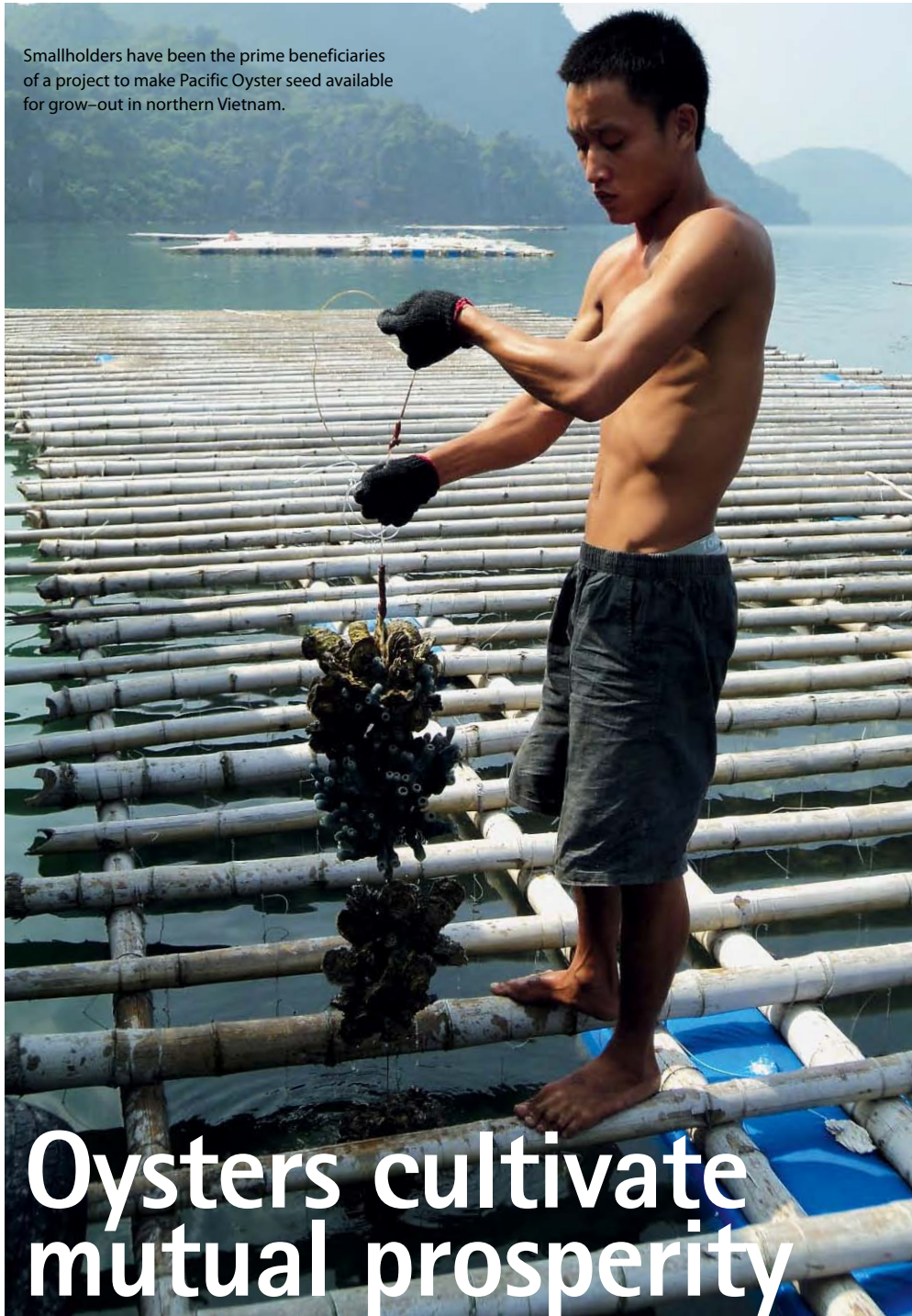
Fiji, Kiribati, Samoa, Solomon Islands, Tonga, Vanuatu

PROJECT: PC/2008/044: Pacific Agribusiness Research for Development Initiative

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Smallholders have been the prime beneficiaries of a project to make Pacific Oyster seed available for grow-out in northern Vietnam.



Oysters cultivate mutual prosperity

An Australian aid project to help impoverished farmers in Vietnam is providing a valuable two-way exchange of research and aquaculture business opportunities.

BY DR GIO BRAIDOTTI

Vietnam's Cat Ba Island is bathed in natural beauty, situated on the edge of the World Heritage-listed Ha Long Bay. Yet for many of its residents—the 'boat families'—life is a struggle to convert ownership of small boats into fishing enterprises capable of meeting basic living costs.

The site recently became home to scientists such as Dr Le Thanh Luu, when funds from Denmark and the US were used to build a major piece of research infrastructure—the National Marine Broodstock Centre (NMBC).

As its director, Dr Luu says the newly built facility can also function as a hatchery, providing affordable seed to farmers to

cultivate in aquaculture operations.

Bringing new species under cultivation can be technically demanding for scientists and farmers alike, and in Vietnam previous attempts to profit from oyster cultivation were largely unsuccessful.

So when it came to the NMBC's bivalve arm, Vietnam sought help from ACIAR to broker a partnership with Australian scientists.

At about the same time, Australia was also in a position to benefit from an influx of innovation in bivalve hatchery technology. Farmers along the banks of the Hawkesbury River in New South Wales (NSW), for instance, were devastated by an outbreak of QX ('Queensland Unknown') disease. Caused by the single-cell parasite *Marteilia sydneyi*, it knocked out Sydney rock oyster production in 2004. In NSW and South Australia, harvests of wild pipis (a small surf clam) also abruptly fell away, shooting prices up from \$16 to \$50 a kilogram.

Faced with complementary sets of strengths and weaknesses, Australia and Vietnam realised that hatchery technology stood to benefit both countries.

In response, in 2007 ACIAR funded a research partnership between Industry & Investment NSW (I&I NSW) and the Research Institute for Aquaculture No 1 (RIA1) in northern Vietnam. Leading the project is Dr Wayne O'Connor who has 25 years' experience producing and growing mollusc species. He heads the bivalve aquaculture group at the Port Stephens Fisheries Institute.

OYSTERS LIFT SMALLHOLDER INCOME

While Asia accounts for most of the world's bivalve aquaculture production—with China alone accounting for 90%—Vietnam, despite its rich coastal resources, produced just 190,000 tonnes in 2005.

"The major constraint in Vietnam was a lack of seed for farmers to grow out," Wayne O'Connor says. "Most of the molluscs produced in 2005 were clams produced by taking seed from the wild and growing it out in specially constructed ponds or on areas of natural beach tended by farmers."

First among the species targeted for cultivation were oysters.

In the space of three years, the project progressed in leaps and bounds. Production of oysters from hatchery seed rose from virtually zero to 100 tonnes in 2007 and then grew annually to 1,000, then 2,000 tonnes. The estimate for 2010 production is about 5,000 tonnes.

Most of that growth was driven by the NMBC hatchery that is currently producing seed in excess of 100 million and has helped

spawn a private broodstock industry.

However, it is the rate at which asset-poor farmers adopted the new technology that stunned the ACIAR team. Dr O'Connor says that, initially, just one of the island's larger farmers was working with the scientists to help establish the new cultivation technology.

"What literally happened is that the Vietnamese are such great adopters of technology that smallholders watched and learned, even before support was provided through RIA1. At the last estimate there were about 200 smallholders and three larger farmers cultivating oysters using RIA1 hatchery seed in Quang Ninh province."

Most are growing their oysters on culch—recycled shells that are tied to a line and slung beneath rafts. Locals say the filter feeders thrive in the warm nutrient-rich waters, growing from a spat to a commercially acceptable mollusc in less than 12 months.

Among the farmers who have adopted the new technology is Pham Thi Lieu. She started growing Tu Hai (otter clams), a specialty of the area, but then branched into oysters. "The first year is difficult and usually a failure, but after that, when you have experience, it can be very simple," she says. "The hardest part is maintaining the stock: keeping the molluscs clean so they aren't attacked by parasites."

The effort proved worthwhile. Oysters do not need feeding, cutting input costs, and earn a farm-gate price in Vietnam of about A\$1.40 a kilogram.

"We have been able to afford a new house, which we built two years ago," Pham Thi Lieu says. "Now we're using our profits to expand our farm. If I have any extra money I will save it for my children and my grandchildren."

Another oyster grower who is expanding is Pham Van Luc, a former fish trader who turned to culturing seafood because of the decline in wild stocks. After a successful trial run with the shellfish, he is now planning to make his farm 10 times bigger.

"I bought seed from the hatchery in Cat Ba," he says. "But because the hatchery doesn't have enough seed to cater for this region, half of my seed is from there and the other half is from another hatchery," he says. "The seed from the centre at Cat Ba is half the price and better quality."

Estimates suggest there are at least 10,000 poor families in the Ha Long Bay area with the ability to adopt or diversify into oyster farming. Restaurants in the coastal tourist areas of Quang Ninh and Hai Phong provinces have enthusiastically embraced 'milky oysters' (Hau Sua) and are promoting the new product to a voracious local market.

BILATERAL NATURE OF ACIAR PARTNERSHIPS

Australia's oyster industry, in contrast, is reliant on high technology. Farmers tend to cultivate sterile 'triploid oysters', which are bred in a hatchery to contain three (rather than two) sets of the chromosomes that make up the oyster genome.

However, the overall range of mollusc species exploited by farmers is miniscule compared with the number cultivated in Asia.

So when it came to the ACIAR partnership, the focus was on testing new technology for the production of triploid oyster broodstock, as well as seizing opportunities to bring new species under cultivation.

Dr O'Connor explains that in many Australian farm environments, triploid oysters provide several advantages, including faster growth rates and the ability to maintain market condition longer.

"When this program started, there was a real demand for triploid oysters, especially in the aftermath of an outbreak of QX disease," he says. "My team had not worked on triploid oysters for a while, so the ACIAR project was an opportunity to test new techniques to produce triploid broodstock on behalf of Australian hatcheries."

That work is ongoing, but it proved providential for farmers when the I&I NSW team was able to work with a commercial hatchery to supply triploid seed when demand threatened to outgrow supply. Particularly affected were growers on NSW's Hawkesbury River, who adopted triploid Pacific oysters in the aftermath of the QX disease disaster.

"Although we developed QX-resistant Sydney rock oysters in 2005, they are comparatively slow growing and would have left farmers without a harvest for several years," Dr O'Connor says. "In contrast, triploid Pacific oysters grow much faster and their adoption on the Hawkesbury helped save that industry."

The ACIAR project also provided an opportunity for the Australian team members to gain experience in Asia with new mollusc species, culture technologies and markets.

"ACIAR fosters partnerships that give Australian scientists the opportunity to look at aquaculture technology for species that are new to Australia," Dr O'Connor says. "Take clams, for instance. Australia has little clam cultivation, whereas farmed edible clams are a huge market in Asia."

That extra experience meant that when harvests of wild pipis recently fell away in NSW and South Australia, Dr O'Connor's team was in a position to develop an aquaculture alternative.

"We were the first to produce pipis in a

hatchery," he says. "We can use that seed either in a restocking program in the wild or for aquaculture production. That means the experience we gained in Vietnamese clam-production technology is now being used in Australia."

Another notable development is the welcome mat that authorities are extending to the Australian aquaculture industry to take up business opportunities in Vietnam.

"That is one of the things ACIAR programs offer—they open the door for Australian industry to become involved in business opportunities in other parts of the world," Dr O'Connor says. "Through the oyster program, that is exactly what has happened in Vietnam."

This was reiterated by Dr Le Thanh Luu at the 2010 Australasian Aquaculture Conference held in Hobart. In a session devoted to Vietnam, Dr Luu said that national and provincial governments are providing assistance to support investment from Australia.

"Northern Vietnam has great potential for aquaculture development for freshwater, brackish water and marine species," he said. "While Vietnam has excellent professional and personal relationships with Australian scientists, there are also investment opportunities for the Australian business community."

"There are opportunities in Vietnamese aquaculture as well as in spin-off and supporting industries, like facilities for intensive culture, feed mills for marine species, production of probiotics for environmental treatment, and production of vaccines for the improvement of health of aquatic animals." ■

PARTNER COUNTRIES

Vietnam

PROJECT: FIS/2005/114: Building bivalve hatchery production capacity in Vietnam and Australia

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Dr Bob Redden, curator of the Australian Temperate Field Crops Collection in Horsham, Victoria, examines germinating faba beans in the bird and insect-proof cage.

PHOTO: PAUL JONES

Floods show value of 'doomsday vault'

Pea varieties collected in an ACIAR project are among the first of Australia's genetic resources headed for safekeeping in the Svalbard Global Seed Vault in Norway.

BY DR GIO BRAIDOTTI

A blue box containing peas and chickpeas attracted an unusual amount of media attention for gene bank curator and ACIAR project leader Dr Bob Redden in January 2011. The seeds were the first sent from Australia to disaster-proof storage in a converted Norwegian coalmine dubbed the 'doomsday vault'.

The journey started at the Australian Temperate Field Crops Collection (ATFCC) in Horsham, Victoria, and terminated on the remote island of Spitsbergen, just 1,300 kilometres from the North Pole. Here, duplicate samples from the world's gene banks are preserved under the stewardship of the Global

Crop Diversity Trust, the Norwegian Government and the Nordic Genetic Resource Center.

The relevance of the vault was amplified when, just days after the consignment left on its journey, the Wimmera River broke its banks and inundated the Horsham township.

"Here you are, sending invaluable seed to a doomsday vault, and then the town hosting the gene bank gets flooded," Dr Redden says. "The ATFCC is safe but the situation underlies the need for a back-up site to safeguard the Australian collection. That's precisely what the Svalbard Global Seed Vault provides: insurance against disaster."

Selected for inclusion in Australia's first consignment were Chinese peas collected in an ACIAR project. This material surprised

geneticists around the world after joint testing in Australia and China found they possess a unique and distinct genetic identity.

"Everybody expected these peas to contain a subset of the diversity present in the Fertile Crescent of the Middle East, where the crop was thought to originate," Dr Redden says. "Instead we found a different gene pool, with unique characteristics."

Dr Redden says that China only shares its genetic resources via mutually beneficial bilateral agreements. China opted to collaborate with ACIAR to collect and evaluate pea and faba beans in a project led by Dr Redden. The pea lines are a valuable source of novel gene variants, which breeders can use to

improve varieties available to farmers. They are currently being tested in Australia and China for traits with large food security impacts, such as salinity tolerance.

Chinese researchers also provided samples of landraces (naturally occurring local varieties) from their national collection and these were included in the Svalbard vault consignment.

“There is a need to invest in food-legume research—such as into peas and faba beans—especially since these crops provide nutritionally valuable proteins while lifting soil fertility by fixing nitrogen,” Dr Redden says.

“The ACIAR-funded collection mission was designed to facilitate the development of varieties with superior qualities . . . properties that encourage pea cultivation by farmers in rainfed areas of China and the grains regions of Australia.”

The chickpea seed is also unique. It was originally collected in the Middle East, but formed part of collections lost during civil conflict. However, some came to Australia and survived in a refrigerator at the University of Adelaide for 30 years, before finding their way to Horsham. “Because it is special material we thought it should go to Svalbard in the first shipment,” Dr Redden says.

The box, weighing 12 kilograms, contains 341 desiccated seed samples that can remain viable for hundreds of years when stored at low temperature. Special attention was taken to ensure that if disaster does strike, the seed can return to Australia without being held up in quarantine. “To fast-track access in case of an emergency, we arranged for AQIS (the Australian Quarantine and Inspection Service) to seal the box so that it retains its quarantine clearance while in Norway.”

The sealed box was carried into the vault by western Victorian farmer Tony Gregson, who is also the former chairman of the board of trustees for Bioversity International, the Rome-based centre for the world’s genetic resources. Once in the vault, the box remains under Australian jurisdiction.

The effort to safeguard the world’s crop biodiversity is considered fundamental to future food security and a keystone of efforts to challenges associated with population growth and climate change in the next 100 years.

“We are looking at feeding nine billion increasingly urbanised people by 2050, with no end in sight,” Dr Redden says. “This growth is putting a huge stress on the world’s ability to feed itself and to lower its carbon footprint.

“A taste of things to come are the impacts from floods in Australia, Pakistan and Brazil. These kinds of disasters underlie the fact the world only has a thin buffer of food reserves. I see the genetic diversity conserved in our

genetic resources as part of a wider, but critical, mission for agriculture over the next century.”

The challenge is to squeeze more productivity from biodiversity and agronomy to cover for a diminishing resource base. Part of that strategy involves innovations in plant genetics. But even more critical is the ability to tap the huge diversity available in the wild relatives of domesticated crops.

“In most cases, when crops were domesticated, it was a once-only event associated with rare mutations, such as the ability to retain mature seed on the plant,” he says. “Only the genetic

The challenge is to squeeze more productivity from biodiversity and agronomy to cover for a diminishing resource base. Part of that strategy involves innovations in plant genetics. But even more critical is the ability to tap the huge diversity available in the wild relatives of domesticated crops.

diversity provided by these rare mutants contributed to the founding gene pool.”

That means only a small part of a wild population’s huge genetic diversity is sampled in domesticated plants. Modern breeding technology, however, makes it possible to tap into the unsampled variation with unprecedented ease. At stake are critical traits including tolerance to heat stress, drought and marginal soils. But to benefit agriculture, the biodiversity of wild relatives must be conserved.

In addition to sponsoring the doomsday vault, the Global Crop Diversity Trust (GCDT) plays a critical role promoting the rescue, understanding, use and long-term conservation of valuable plant genetic resources. It is funded by individual, corporate and government donors. Australia ranks among the leading donor countries, a reflection of the country’s dependence on exotic crops.

GCDT executive director Dr Cary Fowler says wild relatives of crops make up only a few per cent of the world’s gene bank holdings, yet their contribution to commercial agriculture is estimated at more than US\$100 billion per year.

“One example dates back to the 1970s, when an outbreak of grassy stunt virus devastated rice harvests across Asia,” Dr Fowler says. “Scientists from the International Rice Research Institute screened more than 10,000 rice samples for resistance to the disease and found it in a wild relative growing in India. The gene has been

incorporated into most new varieties since the discovery.”

The GCDT has launched a major global search to systematically find, gather, catalogue, use and save the wild relatives of wheat, rice, beans, potato, barley, lentils, chickpeas and other essential food crops.

Erik Solheim, Norwegian Minister of the Environment and International Development, says the project represents one of the most concrete steps taken to date to ensure that agriculture adapts to climate change. “At a more fundamental level, the project also demonstrates the importance of biodiversity and genetic resources for human survival,” Mr Solheim says.

One key constraint in these worldwide conservation efforts is the cumulative impact of years of unreliable and inadequate funding for gene banks. In Australia there is a further crisis looming as a generation of curators are due to retire with no succession plan to ensure an intergenerational transfer of vital skills.

“Gene banks worldwide have been getting by with minimal funding and they are struggling to attract a new generation of curators,” Dr Redden says. “For myself, retirement is not a consideration; there is a lot of unfinished work to ensure biodiversity is conserved and accessible to agriculture.

“I would like to see a way forward before I retire. That includes the creation in Horsham of a National Genetic Resource Centre, with sufficient funds to train and retain a new generation of curators. I’d like to see the job through.” ■

PARTNER COUNTRIES

China

PROJECT: CIM/2000/035: Increased productivity of cool season pulses in rainfed agricultural systems of China and Australia

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HOW ACIAR ADAPTS TO A DYNAMIC WORLD

While ACIAR supports sustainable food security as part of Australia's development assistance program, the centre's own structure has changed in response to dynamic global environments. Here Meryl J. Williams, former chair of the ACIAR Commission, discusses some major trends.

The past six years of my long association with ACIAR were a personally fulfilling time but they coincided with a period of great change. In a dynamic world, ACIAR's own structures matter if the centre is to help others develop human and institutional capacities. When I chaired my last meeting of the ACIAR Commission in September 2010, I reflected on how much had changed as I wished ACIAR a strong and successful future helping farmers link with international agricultural expertise to feed the world.

GOVERNANCE

The first major governance change in ACIAR's history happened midway through my term, in 2007, with the establishment of the ACIAR Commission. It replaced the ACIAR Board of Management (BOM)—a governance structure that had served ACIAR without change for 25 years.

Included were changes to the original *ACIAR Act 1982* that created the position of ACIAR Chief Executive Officer with full responsibilities for the operations of ACIAR. The Policy Advisory Council (PAC) was re-established, but with membership independent of the Commission and with a greater focus on the views of ACIAR's overseas partners. Beth Woods made a welcome return to ACIAR by accepting the position as PAC President.

While the BOM had hands-on approval responsibility for every project that ACIAR undertook, along with oversight and review responsibilities, the new Commission's role is to provide strategic advice to the Minister of Foreign Affairs on ACIAR directions and factors affecting its performance.

Given the Commission's greater emphasis on ACIAR's development assistance mission, we were pleased with the appointment of the Director-General of AusAID and the greater oversight of the Portfolio Secretary. Ministerial responsibility was and remains paramount and with pleasure I can say that all Ministers and Parliamentary

Secretaries I reported to were extremely supportive of ACIAR and its work.

These changes shifted control of the agency from the Board to the chief executive officer, with the Commission providing strategic advice. The approach has made ACIAR more integrated into the whole-of-government and Foreign Affairs and Trade portfolio. This has reduced, in a positive way, ACIAR's independence, positioning it to have greater development impact on the ground.

At the same time, I am a great believer in the advantages to ACIAR of using the experience of key strategic and senior people with outstanding leadership roles in their own fields. The Commission provides a suitable vehicle for this.

LEADERSHIP AND STAFFING

The leadership and staffing of ACIAR have changed considerably. During my first five years, ACIAR was well served by Peter Core as Director and then chief executive officer. Peter led ACIAR through considerable reform, from being primarily program-focused to becoming country-focused, strengthening links with the Australian aid program and AusAID, and improving ACIAR's corporate performance.

Peter also steered ACIAR effectively through the governance reforms and the development of the major amendments to the *ACIAR Act* (in 2007) and improved ACIAR's presentation of information to the public through a rich website. As leader of the research programs, John Skerritt also played a key role until late 2009, when he took up a new leadership role in the Victorian Department of Primary Industries.

In mid 2009, we welcomed our new CEO, Nick Austin, who hit the ground running and has vigorously continued the reform processes, restructuring the regional and research program responsibilities and continuing to strengthen linkages with the aid program. Nick has also embarked on further improving ACIAR's communications. ACIAR is more focused on public outreach than six years ago and has significantly increased its media output.

In recent years, many senior staff have retired after years of

sterling service. I was relieved and delighted, however, that ACIAR recruited an exciting new cadre of research program managers. With programs now focused on countries and regions, and with larger projects mandated, the collegial attitude between research programs is evident.

Another ACIAR strength is its support staff, whose flexibility, cross-skilling and service-first approach I have experienced first-hand.

AUSTRALIA'S AID PROGRAM

As Australia's aid effort gains greater coherence, ACIAR now works much more closely with AusAID. The two organisations' roles were always complementary. But greater coherence, especially by government agencies, has created a platform for better cooperation, such as through single Australian country aid strategies across all sectors and themes.

As a result of the 2007–08 world food-price crisis, agriculture and food security made a comeback to the public agenda, after sliding in priority against other aid issues for more than two decades. This increased the importance of ACIAR's relationships with aid agencies and research providers, and led to the first real increase in ACIAR's base budget for many years.

With economic growth in China, India, Malaysia and Thailand, ACIAR relationships with these countries have shifted to collaborative partnerships or have been phased out or cut. At the same time, work has increased with the Mekong countries and East Timor, new approaches are being taken in the Pacific region, and Africa is back on the agenda.

INTERNATIONAL AGRICULTURAL RESEARCH

ACIAR played a major role in the wide-ranging reforms of the Consultative Group on International Agricultural Research (CGIAR) and now sits on the new Fund Council. Given the deep knowledge of its research program managers, and its leadership in some of the reform processes, ACIAR arguably has the most comprehensive knowledge of any development agency of how best to use the capacities of the CGIAR. ■

The views expressed in this article are those of the author and do not represent the formal opinion of ACIAR.



Celebrating International Women's Day

International Women's Day—8 March—is a global celebration of the economic, political and social achievements of women past, present and future.

ACIAR recognises the key role women play in agriculture, fisheries and forestry industries. This special issue of 'Around ACIAR' showcases some of the achievements of women working with our organisation—from farmers through to senior researchers.



Lao women tending to their livestock.



Farmer Pa Heu with her prized buffalo being conditioned on fodder.

Empowering women

In Aceh 23-24 March 2011, women farmers, agricultural advisors, and staff of universities and non-government organisations gathered at a Women in Agriculture forum. It offered training workshops on leadership skills and technical topics such as post-harvest processing.

The forum, facilitated through an ACIAR project, was implemented by the Indonesian Ministry of Agriculture and Industry and Investment NSW.

There are more than 20 women's farming groups across

Aceh Barat province. The women benefited from training, visiting farms in other areas in Aceh and working closely with extension staff.

Australian Youth Ambassador, Anna Strempel is working with women and local agricultural services in Aceh, identifying how the women's farmer groups can become independent. They want skills in leadership, group management and post harvest processing, and want to know more about new crops and soil management.



Anna Strempel with Aceh women's group coordinator Nazariah interviewing women from a recently formed group in Arongan Lambalek, Aceh Barat.

news and events from around ACIAR

Developing leaders

Three outstanding young female agricultural program managers visited Australia for a six-week program to build their leadership skills and to enhance links with research partners in Australia. All are involved in ACIAR projects, and have demonstrated outstanding potential as future managers and leaders.

Dr Zenaida Gonzaga, assistant professor at Visayas State University in the Philippines, Dr Idha Arsanti, head of collaboration with the Indonesian Agency for Agricultural Research and Development, and Dr El Sotheary, deputy head, Socio Economic Division of the Cambodian Agricultural Research and Development Institute are three of a group of 11 managers who are 2011 ACIAR John Dillon Fellows. They have taken part in a professional training and development program.



ACIAR John Dillon Fellows (from left) Dr Zenaida Gonzaga, Dr Idha Arsanti and Dr El Sotheary at ACIAR House, 7 March 2011.



Members of Siaya district women's farmer group in western Kenya involved in the SIMLESA program.

Testing new technology

African women farmer groups are at the frontline of a five-country ACIAR-funded program that is seeking to substantially improve the yields and returns from maize and legume crops.

Women farmers are testing a range of technologies, such as different tillage techniques, new varieties and use of fertilisers. The program also plans to overhaul the

maize and legume supply chain from farm to market.

In the Siaya district in western Kenya, farm trials are being managed by the Liganwa farm women's group. After the first harvest the women were extremely happy with the increased production. The number of trials has expanded for the second season.

Building skills

In Papua New Guinea, ACIAR is responding to the urgent need to improve the business skills of women who produce and market fruit, vegetables and flowers.

Most smallholders from three Central Province villages shared

past successes, along with future dreams and ideas about growing vegetables. The trial story-telling method is being used to help understand and improve the value chain in horticulture.

Professor Barbara Chambers is



Storytelling sessions and interviews with women in the village of Rigo-Koiari, Central Province, PNG. Barbara Chambers, Gomathy Palaniappan and women smallholders share past successes, future dreams and ideas.

news and events from around ACIAR

working with women from various agencies, such as Dr Gomathy Palaniappan and Norah Omot, who recently returned from ACIAR-supported postgraduate studies in Australia.

Links with non-government organisations such as the PNG Women in Agriculture Development Foundation is building the skills of women leaders in agriculture. The first train-the-trainer workshop for 11 potential leaders was held in September 2010. The workshop approach was one of 'strength-based training', which emphasises collaborative learning and local knowledge.

Overcoming cultural barriers

In northern Laos, as a result of an ACIAR-funded research program, different extension approaches are now used to increase the participation of ethnic minority women in livestock improvement activities.

Special farm 'cross visits' are arranged for women to raise awareness of different livestock raising and trading systems. Staff gender equity is also encouraged

through training and supporting female college students.

Project leader Dr Joanne Millar of Charles Sturt University helped develop guidelines for future extension activities to researchers and extension officers working in these regions to improve the engagement with ethnic women.

Supporting women researchers

Nicole Spiegel is a young and enthusiastic agricultural scientist who spends around five months each year in Tibet working on an ACIAR project helping to improve the nutrition of livestock, especially yaks and sheep.

Rural farmers/herders account for most of Tibet's population and livestock production (yaks, dairy cattle, sheep) is severely limited by poor nutrition, mineral deficiencies and sparsely available feed.

The project team is testing the nutritional status of livestock in the four regions of Tibet, in particular the effects of mineral deficiencies on wool and milk production, growth rates and fertility. Building the research capacity and extension capability of scientists in Tibet is an important aspect of the work.



ACIAR-funded researcher Nicole Spiegel with yaks in Tibet. Yaks are referred to by their owners as 'Nor', meaning precious or jewel.



Nicole Spiegel (left) with counterparts weighing young yaks in Tibet. The ACIAR project aims to improve nutritional health throughout the year to maximise growth during the summer, minimise weight loss over winter and reduce spring mortalities.



Hmong women preparing meal and stylo for pigs.

Gathering feedback from Lao women involved in livestock production.



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OBITUARY

VALE MIRKO STAUFFACHER

It is with deep sadness that we advise of the passing of Dr Mirko Stauffacher, on Saturday 29 January 2011.

Mirko was ACIAR's research program manager for Land and Water Resources, having joined ACIAR in December 2008 from CSIRO. During that tenure he oversaw a project portfolio across a number of partner countries, and was primarily responsible for shaping ACIAR's research responses to the challenges of climate change.

The Land and Water Resources Program deals with broader-scale aspects of the management

a farmer in Bangladesh, continued her association with an ACIAR project encouraging farmers to grow alternative crops in their fallow rice paddies. Through the project, Nasima was able to earn a modest profit for her family by growing wheat and mung beans to complement her rice harvest. She subsequently doubled the area under wheat and mung bean rotation and motivated neighbouring farmers to adopt similar practices.

Beyond the mandate of program manager, Mirko was a valued member of staff, bringing a positive energy to any project he was



Dr Mirko Stauffacher

of land and water resources by focusing on two themes: agricultural water management and agricultural production and land management in the less favourable areas of Asia.

Some of the projects Mirko oversaw included work to promote the sustainable use of water resources in South Asia and implementing the Australian experience of salinity management in Iraq. Some of the work has had a profound impact on the lives of smallholder farmers through boosting incomes and reducing poverty.

One example of how projects within Mirko's program made a real difference is Nasima's story. After losing her husband, Nasima,

engaged in, from designing and implementing process changes to participating in the daily life of ACIAR. His approach to life and work provided an example of decency, humanity and honesty, and in many ways embodied the partnership approach that characterises ACIAR's engagements.

Mirko's work at ACIAR will be continued, and we take comfort in knowing that through that work many people's lives in developing countries across the Asia-Pacific region will be bettered. ACIAR is grateful that we were able to share a part of our lives with Mirko, and that through this others will benefit.

Our thoughts and sympathies are with Mirko's family.

NEW STAFF

ACIAR welcomes two graduate officers—Ms Keshia Hilliam and Mr Brendan Brown. The graduates will be with us for a 12-month development and work experience opportunity. The graduates rotate between the research programs having approximately three to four months experience in each program area working on the delivery of ACIAR's programs.

Keshia Hilliam Bachelor of Animal Science (Hons), Murdoch University:



Whilst studying, Keshia worked on a number of cattle and sheep properties assisting with management of animal health and nutrition. During her degree she studied pasture and soil management, animal anatomy and physiology, parasitology, animal nutrition, animal disease and control, animal welfare, statistical analysis and agricultural economics. She has

also gained work experience on different production farming properties including beef, sheep, dairy and pig production systems. Her interests include equestrian sports and agriculture.

Brendan Brown Bachelor of Science in Agriculture (Hons), University of Sydney:



Brendan has a thirst for international development and this is evidenced by his overseas travels and periods of volunteer work in developing countries. Brendan has studied soil science, agribusiness management, agronomy and plant physiology. He has diverse work experiences from farmhand to contributing to a permaculture project in a small rural village in western Tanzania. His interests include cricket, rugby,

surfing and golf and keeping updated on international developments in the field of agriculture.

MOVERS AND ...



Lisa Wright, director corporate, has taken a new position at AusAID as the Assistant Director General, Communications and Media.

Applications for the corporate director position closed in early February with Dave Shearer acting in the position until a permanent appointment is made. The position of Lisa's executive assistant was also vacated with her departure.

GLOBETROTTERS

ACIAR program managers undertake a hefty travel schedule, with partner visits, project reviews and in-country consultations. We'll report on some of the highlights of trip visits in the next few issues of *Partners*.

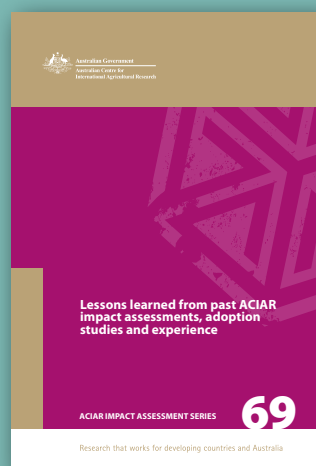
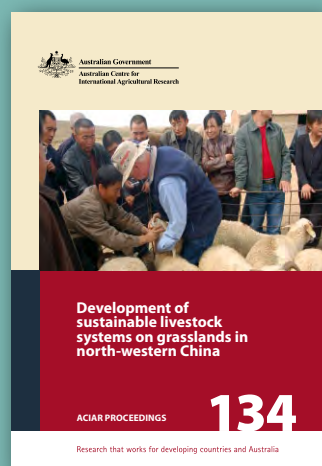
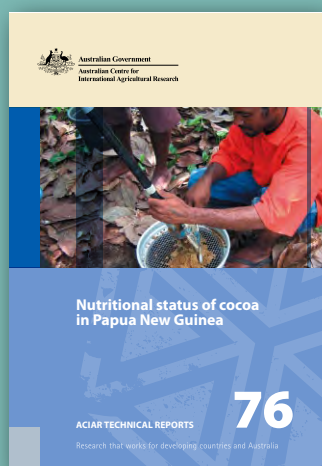
Chris Barlow, ACIAR's Fisheries research program manager, returned from Vietnam in early March. He was accompanied by ACIAR principal regional coordinator for the Mekong, **Gamini Keerthisinghe**, and ACIAR Fisheries program consultant **Geoff Allan**. The main purpose was to attend a workshop. Among other outcomes from the workshop, new fisheries priorities for ACIAR Fisheries program in Vietnam were established. The priorities are:

- improved hatchery practices and molecular biology techniques
- cost-effective feeds and feeding strategies
- improved understanding and management of aquatic animal health
- profitable and environmentally responsible grow-out technologies.

In late February, **Richard Markham** (ACIAR's Pacific Crops research program manager) travelled through Fiji and Vanuatu. He checked on the progress of several projects and investigated participation opportunities in new proposals. He reported that in relation to project PC/2008/003 *Strengthening the Fiji Papaya industry through applied research and information dissemination*, the first shipment of Fijian papaya by sea to New Zealand is scheduled for early March. In Vanuatu, Richard attended the launch of PC/2008/046 *Rehabilitating cocoa for improved livelihoods in the South Pacific*.

ACIAR's Forestry program manager, **Tony Bartlett**, travelled to Laos and Indonesia in January. Tony reported that both ACIAR's forestry projects in Laos are very well regarded and while some good progress has been made, there is still much to do in the plantation forestry sector. The Secretary General of the Indonesian Ministry of Forestry expressed his thanks for the close cooperation with ACIAR, and indicated the importance of the forest sector to Indonesia and therefore the need for strong scientific collaboration and research capacity building to address the key priorities. The Indonesian project partners expressed particular support for the ongoing postgraduate study program and the long-term benefits that it brings.

Earlier in January, ACIAR's program manager for Horticulture, **Les Baxter**, travelled to Bhutan to attend an external review of HORT/2005/142 *Improving mandarin production in Bhutan and Australia through the implementation of on-farm best management practices*. He met with Bhutan stakeholders to discuss horticultural sector priorities, associated projects being implemented and planned by other donor agencies, and a potential follow-on project for mandarin production.



NEW PUBLICATIONS

TECHNICAL REPORTS

Nutritional status of cocoa in Papua New Guinea P. Nelson, M. Webb, S. Berthelsen, G. Curry, D. Yinil and C. Fidelis, TR 76, 68pp. \$22 (plus postage and handling)

PROCEEDINGS

Development of sustainable livestock systems on grasslands in north-western China D.R. Kemp and D.L. Michalk, PR 134, 190pp. \$40 (plus postage and handling)

IMPACT ASSESSMENTS

Lessons learned from past ACIAR impact assessments, adoption studies and experience D. Pearce, IAS 69, 38pp. \$20 (plus postage and handling)

MULTIMEDIA

A short video summarising on-farm trial progress through the ACIAR-funded agricultural research program known as SIMLESA (Sustainable intensification of maize-legume cropping systems for food security in eastern and southern Africa) is now available on the ACIAR website.

Visit: aciar.gov.au and select 'African on-farm trials' from 'Project Stories.'

FINAL REPORTS (AVAILABLE ONLINE ONLY)

AFRICA

Development of emerging farmer crop-livestock systems in northern South Africa Anthony Whitbread, Cam McDonald, Neil Macleod, Jeffery Mkhari, J.J.O. Obhiambo, Victoria Aoydele and Kingsley Ayisi, Final Report for LPS/2002/081, aciar.gov.au/publication/FR2010-27

ASIA

Forage legumes for supplementing village pigs in Lao PDR Werner Stür, Phonepaseuth Phengsavanh, Soukanh Keonouchanh, Viengsavanh Phimpachanvongsod, Ammalay Phengvilaysouk and John Kopinski, Final Report for AH/2004/046, aciar.gov.au/publication/FR2010-21

Assessing mariculture market constraints and potential in South-East Sulawesi: stakeholder engagement and situation analysis Geoff Gooley, La Ode M. Aslan, Hotman Hutauruk, Armen Zulham and Sena De Silva, Final Report for project SMAR/2007/225, aciar.gov.au/publication/FR2010-22

Implementation of rodent management in intensive irrigated rice-production systems in Indonesia and Vietnam Peter R. Brown, Nguyen Huu Huan, Ngo Tien Dugn, Tran Thanh Tung, Nguyen My Phung, Vo Thi Quynh Nga, Quach Thi Que, Sudarmaji, Djafar Baco, Nasaruddin Razak, Murizal Sarwani, Erizal Jamal, Toni Darbas, Cameron Fletcher, Martijn van Grieken and Monica van Wensveen, Final Report for ADP/2003/060, aciar.gov.au/publication/FR2010-23

Community Agricultural Technology Program (CATP) Sheilah S. Vergara, Leonardo Moneva, Conrado Brigoli, Mario Limocon, Aurora Laotoco, Ann Dy and Roberto Dormendo, Final Report for ASEM/2006/059, aciar.gov.au/publication/FR2010-26

Utilisation of local ingredients in commercial pig feeds J.S. Kopinski, La van Kinh, Nguyen Duy Duc Final Report for LPS/2002/079, aciar.gov.au/publication/FR2011-02

The effect of research on agricultural productivity in Indonesia Peter Warr, Final Report for AGB/2010/018, aciar.gov.au/publication/FR2011-04

PNG AND PACIFIC ISLAND COUNTRIES

Assessment and improvement of quality management during postharvest processing and storage of coffee in Papua New Guinea Robert Driscoll, George Szrednicki, Wendy Shaw and Noare Maika, Final Report for ASEM/004/017, aciar.gov.au/publication/FR2010-24

Socioeconomic impact assessment of cocoa pod borer in East New Britain province Papua New Guinea George Curry, Joachim Lummani and Eric Omuru, Final Report for ASEM/2008/034, aciar.gov.au/publication/FR2010-25

Coordination of coffee project suite in Papua New Guinea Anthony Marsh, Final Report for ASEM/2006/033, aciar.gov.au/publication/FR2010-28

Enhancing Papua New Guinea smallholder cocoa production through greater adoption of disease control practices Rosalie Daniel, David Guest, John Konam, Yak Namaliu, Josephine Saul, Maia Wamala and Paul N'nlau, Final Report for ASEM/2003/015, aciar.gov.au/publication/FR2011-01

Identifying pilot sites and research methods for soil health research in the Pacific region Dr Mike Smith, Dr Tony Pattison and Mr John Bagshaw, Final Report for PC/2010/038, aciar.gov.au/FR2011-03

NEW PROJECTS

AGB/2009/053	Improved market engagement for counter-seasonal vegetable producers in north-western Vietnam
AGB/2010/011	Improving the sustainability of cocoa production in eastern Indonesia through integrated pest, disease and soil management in an effective extension and policy environment
AH/2009/001	Increased productivity and reduced risk in pig production and market. Component 1: animal and human health
FST/2009/051	Increasing productivity and profitability of Indonesian smallholder plantations
FST/2009/016	Improving the Papua New Guinea balsa value chain to enhance smallholder livelihoods
FST/2008/039	Enhancement of veneer products from acacia and eucalypt plantations in Vietnam and Australia
FST/2008/030	Overcoming constraints to community-based commercial forestry in Indonesia
HORT/2010/006	Integrated crop management practices to enhance value chain outcomes for the mango industry in Pakistan and Australia—ASLP Phase 2
HORT/2010/003	Social research to foster effective collaboration and strengthen pro-poor value chains
HORT/2010/002	The enhancement of citrus value chain production in Pakistan and Australia through improved orchard management practices
HORT/2010/001	Mango value chain improvement
LWR/2009/046	Improved irrigation water management to increase rice productivity in Cambodia
LPS/2010/007	Strengthening dairy value chains in Pakistan through improved farm management and more effective extension services
LPS/2008/054	Improving smallholder cattle fattening systems based on forage tree legume diets in eastern Indonesia and northern Australia
LPS/2008/049	Overcoming technical and market constraints to the emergence of profitable beef enterprises in the north-western highlands of Vietnam
PC/2009/003	Improving soil health in support of sustainable development in the Pacific
SMCN/2009/031	Watershed evaluation for sustainable use of sloping agricultural land in the southern Philippines
SMCN/2009/021	Climate change affecting land use in the Mekong delta: adaptation of rice-based cropping systems (CLUES)
SMAR/2008/025	Improved seaweed culture and postharvest waste utilisation in South-East Asia

EVENTS

5 June 2011	World Environment Day www.unep.org/wed
20–21 June 2011	Science Meets Parliament (presented by the Federation of Australian Scientific and Technological Societies) Parliament House, Canberra, Australia www.fast.org/index.php?option=com_content&task=view&id=28
15–16 August 2011	Crawford Fund National Conference Parliament House, Canberra, Australia www.crawfordfund.org/conference/conf2011.html
26–29 September 2011	14th International River Symposium Brisbane Convention Centre, Australia www.riversymposium.com
26–29 September 2011	5th World Congress on Conservation Agriculture (ACIAR-sponsored event) (This event is held in conjunction with the 3rd Farming System Design Conference) Brisbane Convention Centre, Australia www.wcca2011.org
April 2013	International Lobster Aquaculture Symposium (ACIAR-sponsored event) Bali email Clive.Jones@deedi.qld.gov.au

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5th World Congress of Conservation Agriculture

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Resilient food systems for a changing worldBrisbane Convention and Exhibition Centre
Brisbane Australia
26–29 September 2011

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Back cover: A farming family lays maize out in the sun to dry in Baucau, East Timor.

PHOTO: ROB WILLIAMS AND SALLY BOLTON, ACIAR

Front cover: Stephanie Belfield in Cambodia helping farmers with pest management issues.

PHOTO: CATHY REID, CRAWFORD FUND



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