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JULY – OCTOBER 2008
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IN RESEARCH FOR DEVELOPMENT

GLOBAL RUST FIGHT
SWEET POTATOES PROSPER
SEEDS OF LIFE—LIVING THE DREAM

GENE REVOLUTION

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HERALDING THE GENE REVOLUTION

Widespread drought in recent years in both the northern and southern hemispheres, combined with increasing awareness that climate change is likely to make such extreme conditions more frequent, is starting to draw the wider community's attention to farming and food security.

There is an awakening to the fact that the world's food crops are vulnerable to rapid changes in environmental parameters, and this combined with diminishing and degrading land and water resources has already placed global food supplies in a precarious position.

The need to rapidly adapt crops—including crops that support livestock production—to cope with environmental and other production constraints, plus lift yields, is placing unprecedented pressure on agricultural science.

Not since the Green Revolution has there been this level of urgency on the work of plant breeders to lift the productivity and environmental resilience of food crops, particularly those that sustain the bulk of the world's populations in developing countries.

The Green Revolution staved off famine in Asia in the 1960s, with new high-yielding rice varieties lifting Asia onto a pathway of economic and social development. Now a new revolution is emerging; crop resilience and adaptability—a gene revolution.

This new challenge is highlighting the critical importance of genetic diversity, which inherently requires a global perspective. It needs genetic resources to be pooled into a global research network that brings capacity and scientific resources to the development of a new generation of high-yielding, highly adaptive and highly robust food crops.

Facilitating this is a role in which ACIAR has long experience, creating research and extension partnerships that have been successfully improving and securing food production in developing countries around the world; particularly in our own Asia–Pacific region.

To help drive this next research priority ACIAR can draw on its long-standing partnerships with the International Agricultural Research Centres (IARCs) that form the Consultative Group of International Agricultural Research (CGIAR). These centres are a critical source of genetic resources and associated expertise.

ACIAR allocates about 20% of its total appropriation to the IARCs, and about half of this investment is allocated to core, or unrestricted, funding. This gives IARCs the flexibility to open new research directions, and maintain long-term programs such as gene banks.

In this issue of *Partners* we look at ACIAR-supported projects that highlight the importance of preserving genetic diversity and how this is fundamental to food security.

Importantly, there is also recognition of the two-way benefit flowing from ACIAR's provision of Australian expertise in international agricultural development. An example is ACIAR's support of research into the threatening rust pathogen Ug99. Successfully breeding cereals that can resist this latest rust biotype is as critical to the Australian grains industry as it is to farming communities in ACIAR's partner countries.

Also by working with the IARCs, Australia is able to draw on expertise or resources not otherwise available in Australia, for example on tree crops like coffee. It can also allow Australian researchers to collaborate offshore to develop biological defences to pests and diseases before they reach Australia.

ACIAR's global presence is highlighted in an upcoming television documentary, *Seed Hunter*, to be screened in Australia and Europe later this year. The documentary by award-winning producer Sally Ingleton covers a seed-collection mission by ICARDA-based Dr Ken Street, whose work has been strongly supported by ACIAR.

The documentary shows that food security and its underlying genetic resource is stirring public interest. Hopefully it will raise community understanding of these issues and the vital role being played by Australia through the activities of ACIAR. ■

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.

Technical enquiries will be passed on to the appropriate researchers for reply. Reprinting of articles, either whole or in part, is welcomed provided that the source is acknowledged.

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ISSN 1031-1009

Published by the Australian Centre for International Agricultural Research (ACIAR)
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Photos: All photos ACIAR unless credited

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Printing:
Finsbury Green
Printed by a carbon neutral process using world's best practice ISO14001 Environment Management Systems.

FSC Mixed Sources
Product group from well-managed forests and other sources
www.fsc.org Cert no. SGS-CoC-2486
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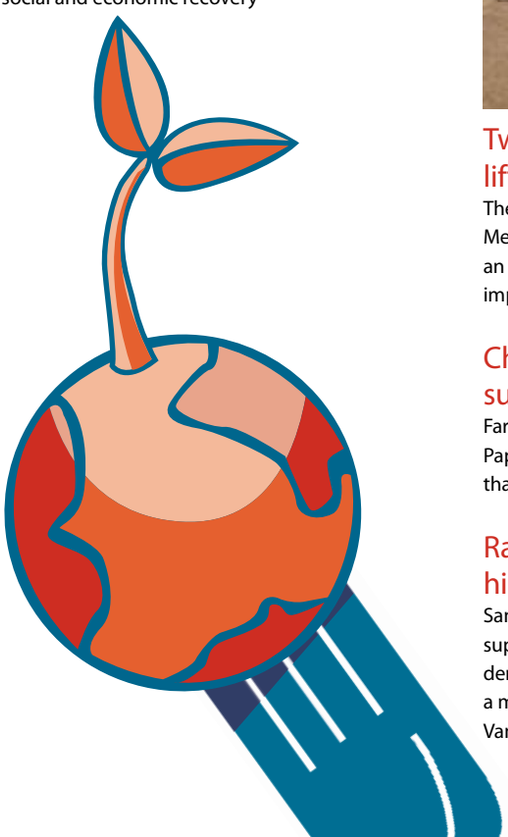
Features



Profile

ACIAR roundup

ACIAR What's new

ARCTIC VAULT HOLDS THE FOOD HOPE OF FUTURE GENERATIONS

Construction of a massive seed storage vault in the Arctic could be a sign of growing political and community awareness of the fragility of agriculture's biological base and the fundamental need to preserve crop biodiversity

The entrance to the Svalbard Global Seed Vault on the remote Norwegian island, Spitsbergen, inside the Arctic Circle.

PHOTO: 360 DEGREE FILMS

PHOTOS: BRAD COLLIS

During a seed-collecting expedition in Armenia in 2005, soldiers explained to Dr Street's team that the area had not yet been cleared for mines.

BY BRAD COLLIS

Syria-based genetic resource scientist Dr Ken Street makes an incongruous sight hunched against the cold, murky, arctic air, peering from beneath frosted eyebrows at the monolithic concrete structure that now houses his work—crop seeds collected half a world away in Central Asia and the Caucasus (CAC).

The structure, jutting from a frozen mountain, is the Svalbard Global Seed Vault—dubbed the 'doomsday vault'—built on the remote Norwegian island of Spitsbergen, deep inside the Arctic Circle.

It is here that seed samples of the world's food crops are to be stored in perpetuity to safeguard against a future natural or man-made calamity. The capacity for farmers to restart agriculture in the aftermath of a widespread, or even localised, catastrophe is now acknowledged as vital for any stable recovery by communities or humanity as a whole.

The vault has special significance for Dr Street because much of the seed he has been collecting in recent years in ACIAR-supported missions has been of ancient varieties—the genetic ancestors of modern cultivars. The germplasm of these species harbours the genetic origins from which cropping has developed over 5,000 years or more. It contains the genetic base, still, for modern plant breeding and the increasingly urgent work to help farmers maintain food supplies in the face of deteriorating climatic and landscape conditions.

This search for modern crops' genetic heritage—the lineage of domesticated crops such as wheat, barley, chickpea and other staple-diet cereals and pulses—has preoccupied Dr Street for the past decade and generated increasing public interest in his work.

Testament to this is the fact that as he surveys the vault, back-dropped by the frozen arctic landscape that will preserve the stored seeds naturally, he is being filmed. Dr Street's seed-collecting missions in CAC have become the subject of a television documentary, *Seed Hunter*, through which the vital role of plant biodiversity is explored.

The documentary, produced and directed by Sally Ingleton from Melbourne-based 360 Degree Films, has been sold to networks worldwide and is scheduled to be screened by the Australian Broadcasting Corporation later this year. The documentary reflects the mounting public awareness and interest in environmental impacts on food production and overarching issues such as crop biodiversity and climate change. The documentary was made with considerable Australian support through ACIAR, the ATSE Crawford Fund, the Grains Research and Development Corporation (GRDC) and the Centre for Legumes in Mediterranean Agriculture in Perth.

Sally Ingleton says the backing of the Australian agencies was critical in allowing her to film Dr Street in the field and gather footage to stimulate the interest of broadcasters. "Initially they were just not interested in a story about seeds, so I had to show them why food security, biodiversity and climate change were not only a big story, but also a story that could be made to appeal to their audiences," she says.

Ms Ingleton is confident she has made a film that will hold a general audience's interest and help people to consider the issue of how food will be grown in the future and why plant breeders must adapt the varieties the world's farmers are growing.

"In particular I hope audiences in developed countries better understand the position of farmers and communities in developing countries, where there is often limited choice in what can be grown," she says. "I also hope the story helps people to better understand the role of modern plant-breeding technologies in adapting crops much quicker than is possible using conventional breeding."

In explaining the relevance of his work, Dr Street points out that a 2° C or 3° C increase in average temperatures may be perceived by most people as merely a comfort issue, not appreciating that a fraction of a degree change can be enough to stop many food plants from flowering and delivering grains and fruits—our food.

Added to this, modern crops have been pampered by eons of farming and breeding for higher yields, or for traits such as whiter bread dough. Consequently, a lot of the 'toughness' of earlier crop types has been whittled back as the genetic base has narrowed.

"So it's the genes that allow the old relatives of modern crops to still flourish in frozen or arid landscapes that need to be found and reintroduced," he says.

This is becoming an urgent race against time. It is the reason Dr Street's small, multi-national team has been turning up unannounced at remote hamlets in countries such as Armenia and Tajikistan, and why its little convoy of mechanically challenged Russian vans keeps stopping for people to jump out to collect seed from scraggy grasses with long Latin names.

"To rebuild the biodiversity of our food crops we are going back through time, backwards through man-made evolution," Dr Street says. "We have been looking for the grasses that were used for bread-making thousands of years ago—at the start of civilisation, when people first saw that keeping and sowing seeds from the best plants gradually improved what they were harvesting. We have been searching for what our far distant ancestors were using; not because they are better, but because they have a wider genetic base. A modern wheat plant might have a few hundred parents, but the ancient varieties had hundreds of thousands, perhaps millions, of parents."

Dr Street's collecting missions have become part of an international program developed under the auspices of the Global Crop Diversity Trust, which works through an endowment to ensure the conservation and availability of crop diversity for food security worldwide. Australia is a major contributor to the Trust mainly through Australia's Development Assistance Program and the GRDC, which is Australia's largest corporate donor. The support reflects the importance to Australia of the conserved biodiversity as, apart from the macadamia nut, all of Australia's major commercial crops have come from seeds imported from overseas. That means the country has no native genetic resources to draw on for crop improvement efforts. ■

PHOTO: 360 DEGREE FILMS

Dr Ken Street storing ICARDA seed in the Svalbard Global Seed Vault.

The gift of food security

By drawing on genetic diversity to improve crop varieties in developing nations that have experienced civil unrest or war, Australians and Australian aid, and ACIAR in particular, help communities along the road to social and economic recovery

BY GIO BRAIDOTTI

Originally established to alleviate world hunger, the international agricultural research centres responsible for the Green Revolution are now participating in a new kind of aid action. With their seed collections that facilitate the development of better-performing crop varieties, the 15 centres of the Consultative Group of International Agricultural Research (CGIAR) and their sponsors, including Australia, are helping nations rebuild run-down or destroyed farming infrastructure following manmade and natural calamities, such as the 2004 tsunami.

Through a series of AusAID–ACIAR joint projects, Australia is heavily involved in these international efforts, which currently include restoring food productivity in Afghanistan, Iraq and East Timor. Unlike humanitarian emergency relief, which provides critical support in a disaster's immediate aftermath, agricultural aid aims to establish a deeper and more enduring food security capability.

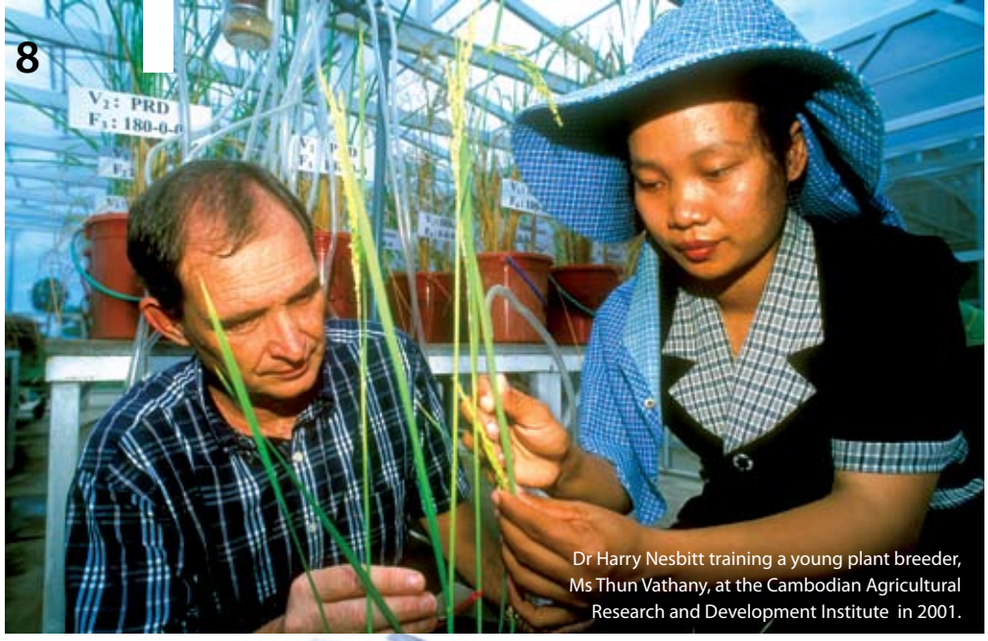
The paradigmatic example of this form of aid is Cambodia following the Khmer Rouge atrocities in the 1970s. Rice production in Cambodia, one of South-East Asia's leading rice exporters in the late 1960s, fell by 84% during the purges that sought to overturn modern agriculture. In the aftermath, not only were the farmers, scientists and agronomists missing or displaced, so were the rice varieties, and their seed stocks, that were needed to keep the population alive.

In emergencies such as this, donor countries willingly provide emergency food supplies, including seed, but this provides only short-term relief. What is missing is the long-term selective breeding that creates crops specifically adapted to any one country's agro-climatic conditions, which include idiosyncrasies in soil, pest, disease and rainfall profiles, in addition to differences in farming practices. Without this in-built adaptation to local conditions, introduced crop varieties tend to perform poorly.

What proved critical in Cambodia's recovery and avoidance of widespread famine was the fact that a CGIAR centre—the International Rice Research Institute (IRRI)—had undertaken a seed-collection mission in Cambodia prior to the crisis that befell the country. Safely stored and catalogued in IRRI's genebank in the Philippines was Cambodia's own germplasm—the rice varieties familiar to farmers.

In the 1980s Australia made special funds available to use this collection to rebuild Cambodia's rice farming, beginning with basic crop production and then moving on to the country's technical and research infrastructure.

Led by Australia's Dr Harry Nesbitt, the



Dr Harry Nesbitt training a young plant breeder, Ms Thun Vathany, at the Cambodian Agricultural Research and Development Institute in 2001.

Dr Brian Palmer, the Seeds of Life's first on-the-ground project leader, made his scientific expertise available to help East Timor improve the performance of its staple crop varieties.

PHOTOS: BRAD COLLIS

Cambodian–IRRI–Australia Project (CIAP) was launched in 1988 and in just seven years achieved a rice surplus. Using the varieties dispatched by IRRI, rice production during the CIAP years increased 70%, with the underlying research infrastructure providing the means to develop a more diversified agricultural economy. For his 13 years on the ground in Cambodia, Dr Nesbitt was awarded a Member of the Order of Australia in 2003.

The impacts of projects such as CIAP are far-reaching for donor and partner countries alike. By promoting food security where people's lives previously rested precariously on indifferent soils, practices and seasons, Australia's agricultural aid system helps to develop stability, security and goodwill.

Not only does ACIAR administer Australia's contribution to the CGIAR centres, ACIAR also participates in collaborative projects and mounts its own missions to support and commission research to develop and deliver improved crop varieties.

The need and the work is ongoing, and ACIAR is providing crucial agricultural support through missions in East Timor and Iraq, and a CGIAR-led program in Afghanistan.

EAST TIMOR

Like the earlier CIAP project in Cambodia, the Seeds of Life (SoL) project in East Timor involves a long-term program to rebuild agriculture in a country facing a precarious and worsening food security situation. A Portuguese colony for 400 years and an Indonesian province from 1975, East Timor faced a looming food crisis when it achieved independence in 1999 after a United Nations-sponsored referendum.

Originally commissioned by ACIAR, SoL was launched in 2000 while East Timor was still in transition from UN administration. With the involvement of Dr Colin Piggin and then Dr Nesbitt, SoL set out to strengthen East Timor's farming system by developing higher-yielding, better adapted varieties for each of the nation's major food crops.

To achieve that goal, SoL called on five CGIAR centres whose genetic resources are now underwriting the development of improved varieties of the most important staple crops:

- irrigated rice—IRRI
- sweet potato—the International Potato Center in Peru
- maize—the International Maize and Wheat Improvement Center (CIMMYT) in Mexico
- cassava—the International Center for Tropical Agriculture in Colombia
- peanuts—the International Crops Research Institute for the Semi-Arid Tropics in India.

With most of East Timor's one million people involved in farming—and cropping providing most of the staple food—the program stands to make a real difference to the 80% of the East Timorese population estimated by the World Food Program to endure food shortages each year.

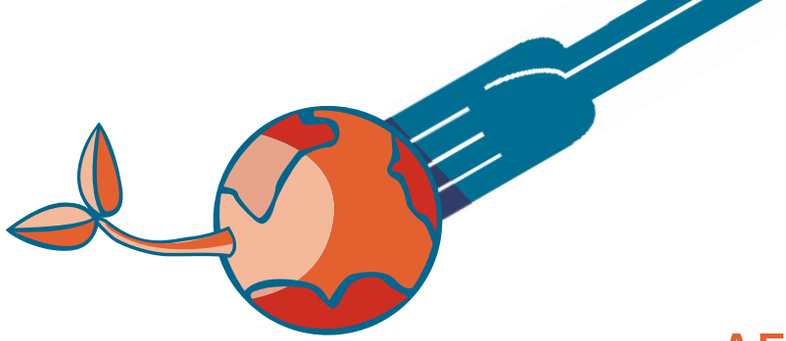
"Since independence, food security in East Timor has been fragile," Dr Nesbitt says. "The nation has a relatively small cropping area—just 336,000 hectares for 140,000 rural households—and farmers are relying on low-yielding varieties, poorly suited to local growing environments."

To unravel the compounding difficulties, there have been two phases to the project. In the first, scientists accessed suitable germplasm, rebuilt the expertise and infrastructure needed to develop new varieties, and began a multi-site testing program to evaluate and select the best adapted lines. In the second phase, which is underway, on-farm trials are testing and promoting the new varieties, a research station and seed storages have been built, and bulking up of seed for distribution is ongoing. A new generation of extension officers and technical staff to liaise with farmers is also being brought into the system—a feat aided by Australia's provision of motorbikes.

From the outset, the program anticipated that a new Ministry of Agriculture would become the principal collaborator. This took place in 2002 with the formation of the Ministry of Agriculture and Fisheries (MAF). Throughout the transition to self-government, the program has been staffed on the ground by Australian advisers, starting with Dr Brian Palmer, SoL's first on-the-ground project leader. It subsequently involved Brian Monaghan—responsible for making the Betano agricultural research station operational—and Rob Williams, who has close ties with the National University of East Timor in Dili, as well as being the current Australian project leader.

With the launch of the AusAID–ACIAR-cofunded second phase in 2005, about 700 East Timorese farmers from different agro-climatic zones have also joined the SoL team, and MAF is increasingly funding positions within the program.

"The on-farm component helps us check whether the new varieties perform well when



cultivated using subsistence farming practices," Mr Williams says. "Because these are low-input systems—in terms of fertilisers, herbicides and pesticides—the trials are answering a really important question, 'How much yield gain is possible based solely on improved varieties and in the absence of other inputs?'"

With three years' data now available, the yield increases achieved on the back of genetic gain have exceeded Mr Williams's expectations. "For maize, harvests are up 40% at both research stations and on farms that did not have access to extra inputs," he says. "Two yellow maize varieties have been released and a sweet-tasting white maize that is no more difficult to pound is on its way."

Similarly, rice yields are 20% higher using an IRRI line highly valued for its taste. Uptake has been widespread, Mr Williams says, with some regions managing to bring two, and even three, rice crops to harvest in one year. "The new rice varieties now dominate some areas. And they taste fantastic. You see, this is not just about yields. It's food—taste is important too."

New sweet potato plantings are proving a success, producing tubers that are up to 10 times larger than the local varieties. Farmers participating in field trials took cuttings to grow on their own land, resulting in new varieties finding their way to market even before trials were completed.

Groundnuts (peanuts) are the cash crop in the system and a large-seeded variety from India is yielding 20–30% more, while offering the desirable qualities of sweet taste and oily texture. Only a cassava release is still outstanding, but four varieties are under trial and are being evaluated for taste, nutritive value and acceptability.

So far SoL has released seven crop varieties, with more in the pipeline—a remarkable success rate by any standard and a stark contrast to the R&D deficit that previously characterised farming in East Timor.

"Since the 1960s crop yields have remained stagnant at a time when comparable countries doubled their harvests," Mr Williams says. "East Timor missed out on those productivity gains. That's what SoL is changing—we are bringing the Green Revolution to East Timor."

AFGHANISTAN

Given his position managing ACIAR's Crop Improvement Program, Dr Paul Fox routinely receives calls from journalists covering Afghanistan.

Despite ongoing efforts to provide Afghan farmers with the means to reverse the nation's debilitating grain yield deficit, Dr Fox is routinely bemused when journalists talk about poppy as the principal crop.

"Wheat is far and away Afghanistan's most important crop," he says. "It accounts for 70% of the nation's crop area, it is the number-one staple crop, and it is crucial in terms of people's food security. Yet according to CIMMYT, crop yields since 1978 have declined about 50% and currently fall short of demand by 1.5 million tonnes a year. That makes wheat the main cropping story in Afghanistan."

In the early 2000s, CGIAR scientists and the Afghan Ministry of Agriculture, Irrigation and Livestock (MAIL) arrived at similar conclusions regarding the extent of the damaging deficit. As in Cambodia in the 1970s, farming infrastructure in Afghanistan had

PHOTO: PHOTOLIBRARY.COM

With wheat yields in Afghanistan falling short of demand by 1.5 million tonnes a year, ACIAR is providing support to help rebuild farming infrastructure and provide better performing wheat and maize varieties.

collapsed. Ominously for future recovery, the damage extended to the nation's agricultural biodiversity.

Although food aid protects against malnutrition in the short term, the country's need to regain food security is acute. Towards that end ACIAR, with funding assistance from AusAID, is supporting CIMMYT-led efforts to improve Afghanistan's wheat and maize varieties, while concurrently strengthening the nation's underlying farming capacity, agricultural infrastructure and scientific facilities.

The need for precisely this capacity building was emphasised recently when the Afghan government and the international donor community met in Paris to decide the nature of future assistance to Afghanistan. Some $15 billion has been spent on reconstruction in Afghanistan since 2001, including about $500 million in the agricultural sector. Yet, according to figures presented at the Paris meeting, the percentage of people living below the minimum dietary level has increased from 30% to 35% in the past year. One statistic highlights the staggering nature of Afghanistan's need to rebuild capacity: foreign aid accounts for 90% of all public expenditure.

With 85% of Afghani people engaged in agriculture, rebuilding national capacity essentially means rebuilding agriculture. An Agricultural Master Plan has been developed that places strong emphasis on cropping and capacity building. In line with these goals, ACIAR-supported projects focus action in four areas:

- screening seed collections for resilient and high-yielding new varieties of wheat and maize
- sourcing hundreds of tonnes of seeds for thousand of farmers
- rebuilding the agricultural infrastructure needed to test, bulk and distribute seed
- training Afghani scientists, technicians and extension workers to carry on the work.

An additional component is sponsoring the inclusion of farmers in testing the performance and acceptability of new varieties using traditional farming practices. Involving the farmers in the evaluation process means they end up ideally situated to form networks, which can bulk up and distribute seed and knowledge.

ACIAR's collaborative approach is identifying wheat varieties for wider release. The first, launched in 2003, was identified in Parwan province, where farmers displayed keen interest in the Solh-02 variety. It was found to yield 50% more than existing varieties and had superior disease-resistance traits. The project is helping ensure that farmer demand for seed is met.

The search for suitable genetic material extends far beyond these efforts. It includes CIMMYT and the International Center for Agricultural Research in the Dry Areas' (ICARDA) own seed collections, plus varieties from neighbouring countries such as Iran and Pakistan. Even further afield, Afghan landraces collected more than 25 years ago for use in Australian breeding efforts are finding their way back to Afghanistan and into the CIMMYT screening program.

Special consideration is given to ensuring varieties are genetically protected from fungal diseases, since Afghani farmers rely exclusively on in-built genetic resistance. The rust diseases in particular have scientists concerned. Stripe (or yellow) rust has rapid rates of evolution capable of breaking down the genetic resistance of new varieties, and a new stem rust biotype called Ug99 is making its way eastward from Africa and has already reached Iran. On both fronts, the expertise of Australian researchers has been recruited to protect Afghanistan's future wheat crops from these threats.

Arrangements are also in place with MAIL to identify Afghani scientists for training. Fifteen scientists have undertaken international courses in breeding and crop evaluation. MAIL staff also received training, including learning diagnostic survey skills of yield-limiting factors.

With efforts on the agricultural front gaining momentum, support from Australia continues to be provided. In May 2008, the Parliamentary Secretary for International Development Assistance, Bob McMullan, made a further $1.5 million in funding available through ACIAR and AusAID, specifically for agriculture-based aid activity.

The support is welcome. CIMMYT's country coordinator in Afghanistan Dr Mahmood Osmanzai says there are still real challenges to close the grain-yield gap. "We have good varieties that will make good bread, but now we have to find ways that let resource-poor farmers get the most from them."

IRAQ

The scene is typical of field days anywhere wheat is cultivated: farmers sitting under a blue sky, listening to a presentation on new wheat varieties. In the background, demonstration wheat fields offer visual proof of the potential for higher yields. Yet this scene is playing out in Ninevah Governorate, in northern Iraq, and is made possible by an AusAID–ACIAR project implemented under the leadership of Australian agronomist Dr Colin Piggin, of ICARDA.

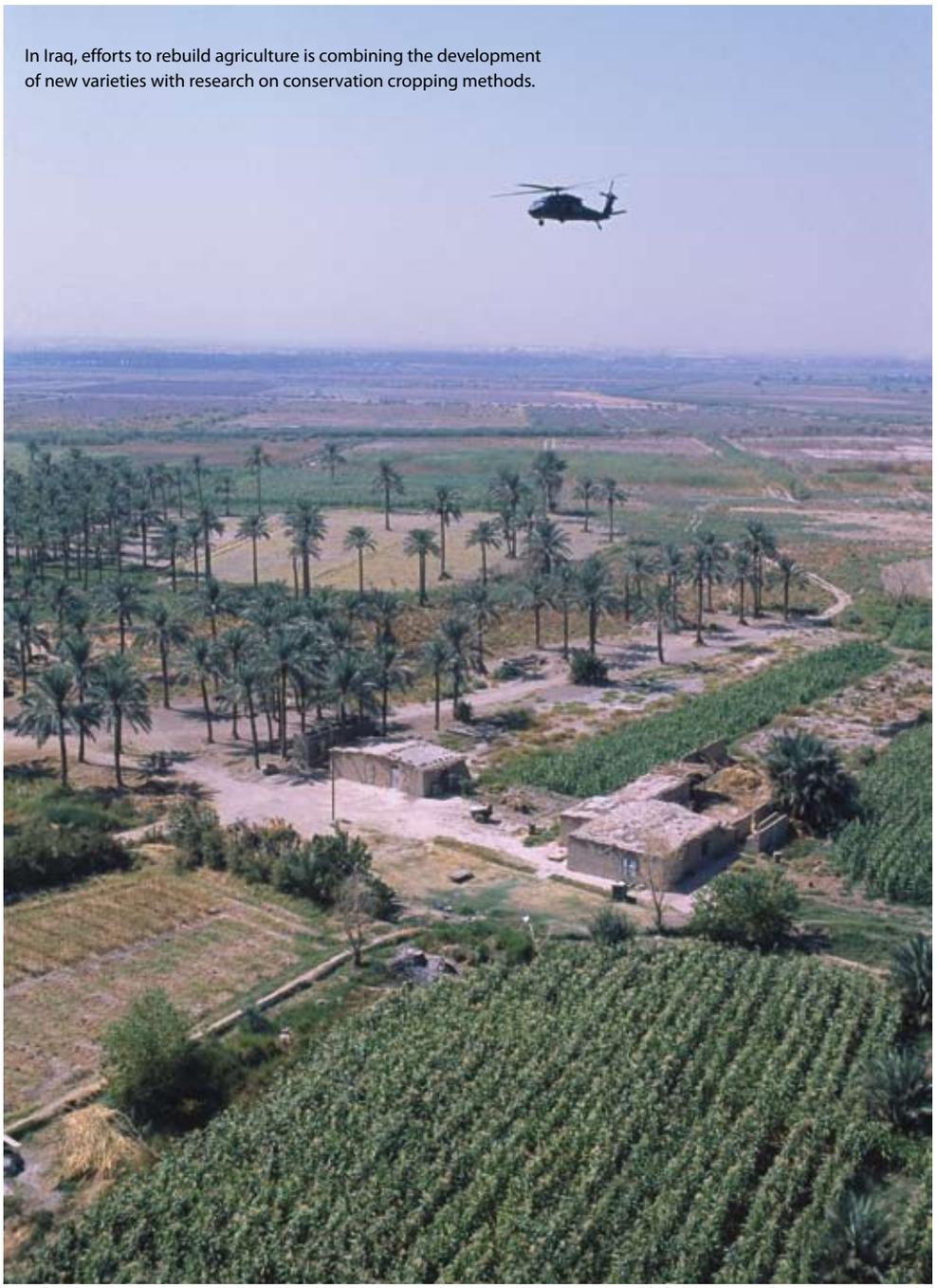
Although Iraq tends to inspire images of deserts, this holds true only in the south of the country. In the north, heading towards the mountains, annual rainfall increases to 400 millimetres in the flatter cropping zone and up to 1,000 mm in some mountainous regions. Wheat and barley are the dominant winter crops in these areas, sown across 3 million of Iraq's 9.5 million hectares of farmland. The northern cropping region provides 70% of the country's staple cereal crops.

The reliance on rain-fed cropping systems is mirrored in many parts of Australia and so too are rainfall and climate patterns. The similarity extends to the problems faced by farmers, such as drought and poor soil nutrition. However, in Iraq wheat yields average 0.73 tonne per hectare, less than half the tonnage achieved in Australia under similar conditions. This difference is mainly attributed to poor crop management and lack of modern crop varieties.

Overcoming these productivity problems is the aim of the ACIAR–ICARDA project that is targeting wheat and barley, as well as pulses and forage legumes. It combines the development of new varieties with research on conservation cropping techniques and a technology adoption program. In all, the project is seeing the oldest cereal-cropping region in the world adopt farming methods of one of the newest cropping countries, Australia.

Unlike most ACIAR projects, the expertise of international research partners is being accessed at arms length. Bypassing the more typical in-country interaction, the Australian partners meet their Iraqi counterparts at ICARDA's headquarters at Aleppo, Syria, to plan, discuss and review activities and achievements.

"Despite being unable to visit our Iraqi partners, we wanted them to have strong ownership of the project," Dr Piggin says. "On that score, they have done an extraordinary job with implementation and reporting; the Iraq Ministry of Agriculture demonstrated excellent leadership. Up and running are demonstrations on 12 major sites in farmers' fields and on research stations, plus the involvement of the agricultural department at the University of Mosul who are just excellent, flexible, lateral



In Iraq, efforts to rebuild agriculture is combining the development of new varieties with research on conservation cropping methods.

PHOTO: PHOTOLIBRARY.COM

thinkers—they really understand what this project is about."

Project implementation within Iraq is led through the State Board of Agricultural Research (SBAR), which has a mandate to devise scientific solutions to the major problems limiting plant and animal production. Training of Iraqi crop scientists occurs at ICARDA's Syrian headquarters or in Australia, with plans underway to extend the training program within the next three-year phase of the project.

High-yielding varieties were selected for planting from the 2005 to the 2008 winter cropping seasons, with farmers invited to participate in these trials. Newly established field nurseries are helping to boost seed for promising varieties, including six wheat and five barley lines. These inspired questions about farming practices that can make the most from the genetic gain.

"From the outset the project involved a lot of agronomists and had a twin focus that included improving farming techniques," Dr Piggin says. "The focus is on conservation cropping, which is made up of three components: zero-tilling of soil, retaining the stubble from the previous crop, and diversifying the rotation rather than sowing cereals in consecutive years."

When the project first started there was no knowledge of conservation cropping and the Iraqis were sceptical that it would work. Traditionally, farmers cut stubble and plough fields before replanting. However, Dr Piggin recalls that three decades ago, Australian farmers and scientists were in the same situation and were equally sceptical. As the Iraqis were encouraged to experiment, gradually the technique proved itself.

"The results surprised the Iraqis," Dr Piggin says. "Yields were found to match or excel fully ploughed plots despite requiring less labour and inputs, such as fuel. The technique provides a lot of efficiencies, including in the amount of water needed since the retention of stubble helps retain soil moisture that can see a crop through in a dry year."

Since the technique requires specialised sowing machinery that drills through stubble to deposit seed, seeders were bought from India. When these proved too small for Iraq farming practices, local seeders were modified and used in field trials in two different rainfall locations where maximum yields rose to 1.8 and 1.9 tonnes a hectare respectively.

"Sowing in Iraq is often done by village contractors who service 50 to 100 farmers," Dr Piggin says. "That centralisation means when they use zero-till, adoption of conservation cropping can spread quickly."

While visiting researchers in Australia in 2008, Dr Saleh Bader from Iraq's Ministry of Agriculture confirmed that the technique is being adopted widely by Middle Eastern farmers.

"We look to Australia as excellent partners and the Australians have very good technologies for zero-till and the conservation of cropping," he said. "It is very important for us to develop the capability of the farmers and the people of the region."

The project's success has resulted in extension activities and plans for a follow-up project that retains farmers at the heart of efforts to develop and distribute cropping options throughout the north's dryland cropping system.

ICARDA will again lead the project, with day-to-day management in Iraq undertaken by the University of Mosul's College of Agriculture and the Ministry of Agriculture, through the SBAR and the Ninevah Directorate of Agriculture. ■

Carp in Vietnam

Genetic identity a key to

Research to understand the genetic diversity of distinct fish populations is playing an important role in rebuilding depleted populations and helping to manage stocks for the future

BY REBECCA THYER

A common concern among fisheries undergoing restocking is the need for information about the genetic identity of the existing fish populations. Without this knowledge, introduced stock can lead to 'genetic competition', a situation that can result in the loss, rather than preservation, of genetic diversity.

ACIAR is supporting efforts to safely restock both marine and freshwater species. Of particular interest are fisheries that are the economic lifeline for coastal communities in the Asian and Asia–Pacific regions.

Included in the ACIAR-sponsored efforts are sandfish. Although little bigger than a thumb, small hatchery-bred juveniles are heralding the start of an important industry for coastal communities in the Philippines and Australia.

Sandfish, or sea cucumbers (*Holothuria scabra*), are being bred in hatcheries as part of an ACIAR-funded project to improve local economies and the environment by releasing juveniles in two ways: into 'sea ranches' for harvesting and into marine protected areas to provide spawning populations that will also promote population expansion in non-protected areas.

Released into unenclosed, well-defined coastal environments, sea-ranched sandfish are allowed to grow to commercial size before being harvested by individuals or groups in 'put-and-take' operations, providing new livelihood options for coastal communities.

As a high-value, yet easily harvested resource, sandfish have been chronically over-exploited throughout the Asia–Pacific region. With many of the region's communities relying on fishing and exporting them for sale as bêche-de-mer (boiled, dried and smoked flesh of sea cucumbers), successful sea-ranching enterprises could have important economic impacts.

Coordinating the ACIAR project is WorldFish Center research fellow Len Garces. He says replenishing stock in two ways—through sea-ranching and restocking in marine protected areas—is important because it informs local communities of the value of managing sea cucumbers and also generates income.

"We know that sandfish have been fished out in most localities in the Asia–Pacific region and that the way to repopulate stocks would be through restocking in protected areas," Mr Garces says. "But that would mean leaving the organisms there, hoping that they would repopulate. Instead, I think restocking should be done together with giving livelihood opportunities to communities. It helps engage them in conservation."

Mr Garces says a prerequisite of the project, which began in May 2007, was the engagement of organised, local communities, educated about coastal resource management principles. Local governments have also supported efforts to conserve and manage coastal resources.

Indeed, the project complements ongoing local initiatives, funded by the Philippines Government, to manage sea cucumber stocks, says Dr Annette Menez, the Luzon coordinator and the ACIAR project's primary investigator.

"We established the first sea-ranching site in partnership with a local fishers' organisation and the local government of Bolinao (on the

A fisherman working the Mekong River

PHOTOS: BRAD COLLIS

securing fish populations

Philippines' northern island Luzon)," she says.

The five-hectare site is managed by the fishers' organisation. Since December 2007, almost 5,000 juvenile sandfish have been released. "Monitoring results indicate good growth in the site with estimated survivorship of around 25%."

Dr Menez says that through exclusive harvest rights to the sea-ranched sandfish, granted by the local government, the project should enhance income for the fishers' organisation.

"The partners will harvest and process the sandfish to produce premium grade bêche de mer. Only sandfish greater than 500 g will be harvested and our partners will be provided with training on quality processing."

Sea-ranching sites also serve as reproductive reserves, she says. "They help replenish sandfish populations in the areas outside the sites. With improved management of the wild population—for example implementing minimum size limits—economic benefits due to the sea-ranching efforts will also accrue to other fishers in the area."

Two other sites are being established in other municipalities in north-western Luzon, while sea ranches are planned for Mindanao, the country's southern island. Sea ranches are also to be trialled with Indigenous Australians at the Warruwi community in the Northern Territory.

Although the second part of the project, which will see juveniles released into wild reserves to restore severely depleted spawning biomass, has been delayed because of the difficulty in finding sites with the right management systems and optimal habitat requirements, the team will persist.

"Most reserves protect coral habitats, but we need seagrass beds with a bit of muddy, sandy soil. We can find them, but they are not protected … mortality rates could be recorded that were due to fishing, not other causes."

Underlying all the restocking work is an understanding of the animal's genetic diversity, Mr Garces says. "Our thinking is to take a precautionary approach. We are adopting a policy whereby if we produce juveniles from a particular locality, we restock in that locality. We are mindful of the stock's genetic makeup."

James Cook University's Cathy Hair, who is leading the Australian component of the project, says it is generally accepted that ranching and restocking programs should release juveniles that are genetically similar to wild members of the same species.

She says this is important because in areas where sandfish genetic studies have been carried out, researchers have found that stocks of sandfish are generally distinct at relatively small spatial scales—as little as 100 to 200 kilometres in some cases.

"The practical application of this is that

PARTNER COUNTRIES: Cambodia, Laos, Thailand, Vietnam and the Philippines

PROJECT DESCRIPTIONS: FIS/2003/023: Stock structure of two important Mekong River carp species; FIS/2003/059: Sea-ranching and restocking sandfish in Asia–Pacific

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DNA-based technology is being made available to support fisheries management and restocking efforts in the Philippines, where sea ranching of sea cucumbers is being established (above), and in the Mekong Basin, where a better understanding of mud carp species (centre) is being sought to help local fishers (left).

we should source hatchery broodstock from an area close to where progeny will be later released," she says.

WorldFish Center scientists have used this knowledge to release cultured juveniles in a way that preserves the genetic diversity of existing stocks, many of which are quite isolated.

Mr Garces says to do otherwise could upset the marine environment's ecological balance. "It could cause some imbalances because an introduced organism has different characteristics, and instead of maintaining the diversity of an area, we could in fact reduce it."

Before restocking or other management programs take place, researchers often use DNA diagnostic tools—similar to those used to solve crimes in forensic science—to garner information about the structure of certain fish stocks.

Queensland University of Technology's (QUT) Dr Peter Mather used similar diagnostic tools in an ACIAR-funded freshwater project with the Mekong River Commission (MRC) to better understand the stock structure of two important carp species—*Henicorynchus siamensis* and *H. lobatus*.

Very common in the Mekong system, the fish were thought to be one migratory species, he says. However, researchers discovered there were multiple distinct stocks of both species with quite different genetic characteristics and distribution patterns across the Mekong River Basin.

Dr Mather says the genetic approach used was to evaluate variation in marker genes in the two species in different parts of the river system. "If the frequency of those genes is the same in widely distributed populations, then you can assume that individuals are dispersing through the whole system or are moving to reproduce collectively with other populations elsewhere.

"However, if the genes are different in frequency, or unique forms are present in different places, you can assume the fish are semi-independent or independent populations."

Although people who handle the fish cannot readily tell them apart using external morphological traits, the project team did find that the two carp species had different genetic characteristics.

Using mitochondrial DNA (mtDNA) tools, Dr Mather and collaborators from government fisheries agencies in Cambodia, Laos PDR, Thailand and Vietnam examined the two species to help inform fisheries bodies about fish stocks.

Unlike nuclear DNA, which is inherited from both parents and in which genes are rearranged in the process of recombination, there is usually no change in mtDNA from mother to offspring.

This means that if there is a difference in how fish populations have evolved, there will be a much bigger effect on mtDNA than on nuclear DNA. "That is why we target it first, because if we are going to see differentiation between populations, it will be more apparent in mtDNA than in nuclear DNA," Dr Mather says. "So we use that as a starting point in demonstrating the utility of taking a genetic approach."

He says the more these tools are used, the more researchers and fisheries management bodies will learn about stock structures. "What was thought to be one large stock could actually be lots of smaller populations behaving either completely independently or semi-independently."

Dr Mather says this builds important information for future management decisions. "If there is overpressure in an area considered to have a single population, and which turns out to be multiple populations, it could lead to local population declines or extinction that may not be naturally recolonised."

That is why fish stocks need to be identified. "Our point was to demonstrate the approach to identifying fish stocks and then fisheries bodies are able make decisions to conserve that biodiversity."

Dr Mather's team, which includes Dr David Hurwood, a postdoctoral researcher at QUT, has run workshops in Thailand to teach MRC fisheries researchers about these techniques. Although a problem in the region was a lack of laboratories, in recent times better facilities have been set up in Vietnam and Thailand and are starting to do similar work routinely on freshwater and marine species.

Although the project has finished, Dr Mather has a number of international postgraduate students from Mekong River Basin institutions who are gaining the technical and theoretical experience to run similar studies on other Mekong River Basin species.

Interestingly for DNA detectives such as Dr Mather, an understanding of an area's geography and how it evolved can often be as important as DNA diagnostic tools in understanding fish-stock structure.

Dr Mather says once gene patterns are clarified, a greater understanding of how those patterns evolved can be made. "That is dependent on two sets of information: what geomorphology can tell us about changes in landform and river-drainage patterns over time, and the animal's life-history characteristics."

It has helped the team understand how the Mekong River carp species evolved to be so different. "Their evolutionary histories are different and this has influenced their patterns of gene frequencies in divergent ways."

What they have found from their work is that one of the species is moving through that area freely and the other isn't. "Each year people have been observing mass migrations assuming that both species have been moving through this area against the current, but that is not the case for one of the species."

Dr Mather says it is this sort of genetic information that ensures restocking and protection work can be done in an environmentally and ecologically acceptable way, so that important genetic diversity is maintained. ■

Researchers join forces to fight global threat to crops

PHOTO: MELISSA MARINO

Scientists around the world are working against the clock to build a genetic defence against a wheat disease that some fear could seriously destabilise global food security

Dr Paul Fox, ACIAR Crop Improvement and Management research program manager in New Delhi for the MAS wheat breeding program planning workshop.

BY MELISSA MARINO

A new variant of the ancient crop scourge, rust, is the target of a partnership between Australia and India to harness biotechnology in a bid to 'bullet-proof' wheat against this highly adaptable pathogen that has shown it can readily develop resistance to traditional genetic defences.

The emergence and steady spread of the new, virulent strain of stem rust fungus, Ug99, has heightened the urgency of the research to build new genetic resistances in wheat to protect against the pathogen, which is said to have the potential to not just reduce yields, but wipe out whole crops.

Named Ug99 after it was detected in Uganda in 1999, it has since spread on prevailing winds across the Red Sea to Yemen, and earlier this year was detected in Iran—far too close for anyone's comfort to the fertile Indo-Gangetic Plain of Pakistan and India, one of the world's most important bread baskets.

Although Ug99 is not yet known to be in Australia, it is important that breeding efforts ensure there is effective resistance in Australian wheat varieties. For India, which is at the front-line of a possible Ug99 incursion, the effort to build robust defences against it is of obvious and immediate importance.

Enter ACIAR and the Indian Council for Agricultural Research (ICAR) which, through a five-year marker-assisted selection wheat breeding program, are bringing together genetic resources of both countries to, among several objectives, boost resistance to Ug99 in wheat.

Dr Evans Lagudah from CSIRO Plant Industry, who is leading the Ug99 project within the broader joint program, says the aim is to avoid the use of just one resistance gene in wheat varieties. "It is to bring in genetic diversity, utilise different sources of plant resistance genes, use them in combination to ensure durable resistance against stem rust," he says.

It is a vision shared by Dr Paul Fox, ACIAR's Crop Improvement and Management research program manager, who says international collaboration will minimise the chance of any individual country releasing a variety with just one source of resistance.

"What you are doing then is potentially giving the pathogen a chance to mutate and overcome the resistance and that gene then becomes useless for the whole world," he says. "But if you had three effective genes in a resistant variety, the chances of getting simultaneous mutations to overcome the three genes is almost zero."

Of particular concern to scientists is that Ug99 can overcome many of the traditional resistance genes bred into wheat over decades to ward against stem rust, including the widely deployed resistance gene Sr31.

It has also shown a deft ability to mutate and overcome resistance genes such as Sr24, which at one point had protected against Ug99.

Resistance genes are facing further pressure with the spread of Ug99 to the Middle East—home to the barberry bush. This is an alternate host to stem rust, allowing the pathogen to survive after wheat is harvested and thus, evolve faster. And, while some scientists feel this evolution could result in pathogen strains with less virulence rather than more, no-one knows for sure what could arise.

Now, at a time when the world faces low wheat stocks, increasing demand, rising prices and predictions of global food shortages, most commercial wheat varieties are vulnerable.

> "It is to bring in genetic diversity, utilise different sources of plant resistance genes, use them in combination to ensure durable resistance against stem rust."
> —Dr Evans Lagudah

So as Ug99 knocks on the door of the bread basket of the subcontinent, scientists have stepped up their efforts against the disease, and the level of international cooperation. They are racing to breed wheat varieties with multiple sources of resistance from germplasm sourced from around the world before any spell of wet and humid weather creates the conditions for an epidemic.

The ACIAR–ICAR five-year program, whose Ug99 project is partnered in Australia by CSIRO Plant Industry and the University of Sydney's Plant Breeding Institute (PBI), is employing marker-assisted selection (MAS) to breed not only for boosted protection against rust and other diseases, but also for tolerance to drought and other environmental stresses, as well as improved quality.

MAS is a breeding technique employing 'molecular markers'—usually short fragments of DNA on specific regions of a chromosome near the target gene—which effectively 'flag' to breeders whether specific traits have been inherited. This means selection of traits is quicker and more efficient, which can potentially mean new varieties can be developed sooner.

The research will also feed into an escalating international response to Ug99, notably addressed this year by a $26.8 million Durable Rust Resistance in Wheat project involving researchers from 15 institutes worldwide and administered by Cornell University in the US under the umbrella of the Bourlag Global Rust Initiative (BGRI). Funding for the Durable Rust Resistance in Wheat project is being provided by the Bill and Melinda Gates Foundation.

While screening world wheat germplasm and developing markers for Ug99 resistance genes to complement the Australian–Indian research, the BGRI is also on the ground in Ug99 'hot spots' developing critical infrastructure, and research skills, and undertaking surveillance on the stem rust pathogen.

The global commitment will also be marked by the 11th International Wheat Genetics Symposium in Brisbane this August, featuring an ACIAR-sponsored session devoted to Ug99 involving all the key international players to formally coordinate the research effort.

Dr Fox says the aim is to develop a global action plan "so we can get the biggest bang for our bucks". He says international researchers will be ensuring there is no duplication and striving to have everyone's work as complementary as possible.

Wheat under cultivation on permanent raised beds demonstrates the value of good soil and water management.

The head of the Indian Agricultural Research Institute Department of Genetics, Dr K.V. Prabhu, who is also on the Australia–India MAS breeding program management committee, says productivity, waterlogging and the threat of Ug99 are key concerns for Indian wheat growers.

The partnership is an opportunity to address those concerns in advance and prepare, so the impact will not be as disastrous, he says. "This is a frank partnership on a scientific basis, looking at the strong points that both countries have and using those on a shared basis," he says.

Australia, although a small player in global wheat production, is in a strong position to help fight Ug99's spread. It has a long and successful record in combating rust through the 35-year Australian Cereal Rust Control Program (ACRCP) funded today largely by the Grains Research and Development Corporation and hosted by ACIAR Ug99 project partner, the University of Sydney's PBI, which is also home to an invaluable bank of knowledge and thousands of rust pathogen isolates dating back half a century.

ACIAR's other Australian Ug99 project partner, CSIRO Plant Industry, is the group behind the world's first cloned genes for plant rust resistance (in flax and maize) and has developed the acclaimed universal molecular markers that identify stripe rust and leaf rust

PHOTO: MELISSA MARINO

Australian Cereal Rust Control Program (ACRCP) head Professor Robert Park, from the University of Sydney's Plant Breeding Institute, at the MAS wheat breeding program planning workshop in New Delhi.

PARTNER COUNTRY: India

PROJECT DESCRIPTION: CIM/2007/064: Linking India and Australia to a global strategy for the Ug99 stem rust pathotype

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resistance genes Lr34/Yr18, as well as markers for stem rust resistance genes including Sr24 and Sr31.

Also, and importantly, Australia has not bred extensively with the rust resistance gene Sr31, perhaps the world's most commonly used defence against rust and which Ug99 can overcome.

ACRCP head Professor Robert Park from the Plant Breeding Institute, who is also working on the Cornell project, explains that despite Sr31's global popularity driven by rust resistance and yield advantage, Australian breeders shied away from using it in milling wheats because of an associated defect known as 'sticky dough'.

This forced researchers and breeders to focus on other resistance genes to control stem rust. "Now we're in a very strong position to contribute internationally," he says. "Because we haven't used Sr31 we have a lot of useful resistance genes for stem rust in good, high-yielding varieties that other people can use."

Tests done in Kenya on 75 Australian cultivars showed around one third (29) were susceptible to the Ug99 strain that overcomes both Sr31 and Sr24. And now, joining forces with India will increase the potential for breeding varieties with even better resistance to Ug99.

India and Australia are a good match says Dr Fox, growing similar styles of wheat, but with important differences in their genetic backgrounds. "A lot of the genes India has been using for rust resistance are quite distinct from those Australia has been using so if we can come up with some combinations of genes from both countries they will be more robust than what either of us could come up with in isolation," he says.

In a key part of the current project, hundreds of varieties from Australia and India are being grown and screened for resistance against rust pathogens. The genomes of any resistant plant identified will be analysed and the genes that may be the source of that resistance identified. From there, molecular markers can be developed and used in breeding.

Already, the CSIRO team is busy developing markers for two known genes effective against Ug99—Sr13 and Sr22, two 'seedling resistance' genes that are quite strong but potentially can become short-lived when deployed alone.

Dr Lagudah says both of these genes exist in Australian varieties, but not in combination. They are in some Indian varieties but not in high frequency.

"The objective is to breed these two genes together as a 'package', ultimately into both Indian and Australian wheats," he says. "The advantage of having the two genes together is that it is much more difficult for a pathogen to overcome two genes than one at a time."

By using molecular markers, breeders will be able to identify specific regions of the chromosome that will always flag whether the Sr13 and Sr22 genes have been inherited in progeny without needing to wait for the plant to grow and express the genes' traits.

When the breeders make their crosses, they can select both genes and ensure the derived material carries both resistances. "Developing molecular tags is an effective tool that allows for the stacking of genes," Dr Lagudah says.

In the longer term, the researchers will also characterise and locate partial resistance but longer lasting 'adult plant resistance' genes that may be present in the Australian variety Hartog, and stack those with seedling resistance genes.

The stem-rust resistance genes could also be stacked with the molecular-tagged stripe and leaf-rust resistance genes Lr34/Yr18, further boosting resistance. These genes, that are always inherited together, not only provide broad-spectrum resistance to leaf and stripe rust, but have also been shown to enhance the level of stem-rust resistance genes in some wheat cultivars, Dr Lagudah says. "So the idea is to use genes like Lr34/Yr18 as the backbone upon which you build."

Although the advantages of building robust defences against Ug99 are clear in countries, such as India, that are geographically close to places where the pathogen is known to have spread, Australia too, will directly benefit from the research.

"We need to be aware of these exotic threats and do pre-emptive breeding," Professor Park says. "Ug99 may never turn up in Australia, or it might already be here. It's not a foregone conclusion but we have to make sure we have effective resistance in our material and stay engaged with the global community." ■

Twin genes to help India lift meat production

The same gene that lifted fecundity in Australian Merinos more than 60 years ago has been traced to an Indian breed and is now helping Indian shepherds improve sheep production

BY KELLIE PENFOLD

A single gene with the ability to promote twinning in sheep has attracted breeders' attention because it promises a simple genetic route for lifting production at a time of unprecedented global demand for meat. Called the Booroola fecundity, or *FecB* gene, after the Australian property on which it was discovered, the gene's origins were recently traced back to India's Garole breed.

The finding is playing a pivotal role in ACIAR-funded projects that, for 10 years, have brought together Indian and Australian scientists and shepherds in the Indian state of Maharashtra. Collaborating on the research are India's Nimbkar Agricultural Research Institute (NARI) and National Chemical Laboratory (NCL), along with Australia's University of New England (UNE) at Armidale and the University of Melbourne.

The aim is to share genetic resources and management expertise in a quest for productivity gains for the poorer shepherd communities of Maharashtra and the Australian Merino flock, currently at its lowest level since 1924.

In India, there are about five million shepherd families running 62 million sheep and 125 million goats. Flock-owners often cooperate to raise the combined size of the migrating ewar, thereby reducing costs and improving security. Shepherds, whose income is derived from meat production, run between 25 to 100 ewes, with each ewe producing a single lamb every 10 to 12 months.

Project leader in India, NARI's Dr Chanda Nimbkar, says it is a high priority of the state and national governments of India to increase production of sheep meat and other livestock products to meet growing demand. Another priority is to increase supply of meat at reasonable prices in the rural, less affluent sections of society.

Surveys by Australian project leader, Professor Steve Walkden-Brown from UNE, found that while goats regularly produce twins, the shepherds place a high value on the rare ewes that regularly produce twins. A higher reproduction rate in ewes means the ability to run fewer animals to produce the same number of lambs, thus easing grazing pressure and maximising profits.

PARTNER COUNTRY: India

PROJECT DESCRIPTION: AH/2002/038: Improved productivity, profitability and sustainability of sheep production in Maharashtra, India through genetically enhanced prolificacy, growth and parasite resistance

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PHOTOS: STEVE WALKDEN-BROWN

Shepherds collaborating with the project team proudly display a young Deccani ram they have selected.

Professor Steve Walkden-Brown from UNE and Dr Chanda Nimbkar from NARI snack on fresh chick peas while visiting shepherds' flocks in February, 2007.

To capture the benefit to shepherds of the twinning trait, efforts were made to introduce the only fecund sheep breed in India—the Garole breed—to the Deccan Plateau of Maharashtra. The Garole breed also has better internal parasite resistance than the local Deccani breed, another desirable trait that can improve productivity.

These efforts faltered because the Garole breed is small and unattractive to Deccani shepherds, and the introduced sheep did not thrive on the plateau. The project did, however, establish that the *FecB* gene accounts for the Garole breed's fecundity. The finding confirmed earlier theories that the presence of the gene in Australia originated in the 'Bengal sheep' introduced into Australia from Calcutta in 1792–93.

The decision was then made to breed the high-fecundity and parasite-resistance traits from the Garole into the Deccani sheep, while avoiding the transfer of other, unwanted Garole characteristics. Achieving that goal meant using complex crossbreeding and selection techniques to introgress the *FecB* gene into the Deccani genome.

"Fortunately, the nature of the *FecB* gene means that, over time, it can be introduced to different strains of sheep and rather quickly be retained, while discarding undesirable traits from the breed of origin," Professor Walkden-Brown says. "The ability to express the twinning trait is then governed by whether an animal has inherited zero, one or two copies of *FecB*."

The gene's identification by three different international research groups in 2001 has meant that DNA tests can now easily determine how many copies a ram, ewe and lamb has inherited. The test provides unprecedented opportunities to select for the twinning trait during breeding. Previously, establishing its presence in ewes required examining the ovaries of sexually mature ewes while rams took even longer, requiring ovary evaluation of its daughters.

With NARI's Dr Chanda Nimbkar using an ACIAR fellowship to complete a PhD in animal genetics at UNE, the way was paved for the project to undertake large-scale DNA testing. In Australia, DNA samples were collected from Merino ewes on a southern New South Wales property. In India, Dr Nimbkar's NARI team took samples from Garole and Deccani crossbred sheep. The project also examined genetic factors controlling the inheritance of other production traits in NARI's research flock of 500 ewes.

The project amounted to the first large-scale genotyping for the *FecB* gene in flocks maintained under commercial Australian conditions. The gene was found to have no adverse effect on traits such as wool growth and quality. However, increases in litter size proved difficult to manage in Australia's extensive sheep production systems since lamb mortality was correspondingly higher. In Australia, the benefits of *FecB* were less clear than in India.

The NARI scientists, in contrast, found that the Indian ewes carrying zero, one and two copies of the *FecB*, on average, carried litter sizes of 1.02, 1.57 and 1.63 and an average number of lambs weaned of 0.96, 1.33 and 1.30 respectively.

"If the basis of the more moderate litter sizes in *FecB*-carrying ewes in India can be discovered and applied to the Australian Merino, it could revive the use of *FecB* as a way to improve reproductive rate at a manageable level," Professor Walkden-Brown says.

In contrast, the research focus in India shifted to the shepherds' flocks in a bid to evaluate the productivity of *FecB* sheep run under real farming conditions. The resulting information provides the basis for introducing genetic gain into the shepherds' flocks. Strikingly, litter sizes under shepherd management were found to be similar to NARI's results. The majority of the increased lambs survive and go on to be sold, substantially improving the profit margin per ewe.

"Genetics and the environment invariably operate in tandem and it is our feeling that to really get the most benefit out of ewes carrying the *FecB* gene, shepherds will need to modify their management slightly to provide extra nutrition to the pregnant ewes and young lambs at critical times," Professor Walkden-Brown says.

In 2007, 582 shepherds attended nine different training programs run by NARI, capitalising on one of the project's strengths—its emphasis on working with shepherds who are actually earning their living from sheep (although 582 out of 5 million is small, it is a start.)

Also critical to the project is the 'can do' attitude of the NARI partners, Professor Walkden-Brown says. "NARI is a dynamic, independent, non-government research organisation located in rural India, with good links to local farmers. Because the nucleus flock is run at NARI, under traditional herding methods, staff have great first-hand experience with the sheep and can relate easily with the shepherds."

Sheep manure and urine is a valuable by-product of sheep raising in Maharashtra and shepherds are often paid to 'fold' or camp their sheep on crop land overnight. After breakfast, which the shepherds' family can be seen preparing, when the dew has dried the flock is moved to a new grazing area. These Deccani sheep have been recently shorn and decorative unshorn tufts of wool can be seen on some sheep.

Young crossbred Deccani rams carrying the *FecB* gene at NARI.

In 2007 the value of the research was recognised by the Indian Government, with NARI and NCL being the joint winners of the Council of Scientific and Industrial Research Award for 2007 for Science and Technology Innovations for Rural Development.

Project participants are now planning to host an international workshop in Pune, India, on the application of the *FecB* gene in sheep breeding programs. It is scheduled for November 2008.

The workshop will bring together scientists from around the world to discuss their recent findings and the best ways to disseminate and use the *FecB* gene for the benefit of sheep producers in India and elsewhere. Details of the workshop can be found at its website (www.une.edu.au/ers/hnt-workshop.php). The proceedings will be published by ACIAR and will capture many of the results of more than a decade of ACIAR-funded work on meat sheep improvement in India. ■

Choice is the sweet taste of success for sweet potatoes

Farmer involvement in sweet potato variety trials in Papua New Guinea is giving people a wider choice that, in turn, broadens people's income prospects

PHOTOS: WORLD VISION

BY ROBIN TAYLOR

When Sharryl Ivahupa saw farmers scrambling to gather as many different sweet potato types as possible from the field trial being harvested, she could see they recognised the value of having a wide choice of pre-tested genetic material.

Ms Ivahupa of World Vision Papua New Guinea (PNG) is the project manager of an ACIAR-supported sweet potato evaluation trial involving World Vision, the National Agricultural Research Institute (NARI) and farmers of Madang province.

Project coordinator Jonathan Treagust, of World Vision Australia, says it is the largest on-farm research trial undertaken in PNG.

Everyone helps to record tuber weights at harvest.

PARTNER COUNTRY: Papua New Guinea

PROJECT DESCRIPTION: SMCN/2003/010: Farmer evaluation and multiplication of species varieties in north coast of PNG

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Sweet potato is an important staple food in the region and over three years the project tested 16 varieties at about 267 sites during both wet and dry seasons. Farmers evaluated them using a number of criteria such as taste, yield and time of maturity.

Initially the plan was to select four varieties that could be recommended across the whole province. However, it soon became clear to the project team that farmers did not want to be limited to four varieties. It seems increasing yield is only one element of food security—farmers also want choice and options, Ms Ivahupa says.

"People are happy having all 14 varieties and want to have the choice to decide over a much longer period," she says. "They want access to some varieties that mature early and others that mature later. They want some to be drought resistant and others to tolerate water. They want the choice and to be able to carry on this research themselves."

For World Vision, this project represents a new area of work in PNG. Mr Treagust says it was a natural fit when World Vision sought to expand its food security projects in Madang, where sweet potato is the most important staple crop for both rural and town populations.

"Providing this range of varieties to farmers has allowed women—who are involved in every step, from planting to food preparation—to have the decision-making ability based on their individual and ever-changing needs," Mr Treagust says.

In order of importance, the agronomic characteristics on which farmers rate sweet potato are tuber size, smooth skin, number of tubers, skin colour and tuber shape. Taste tests revealed a preference for sweet tubers, followed by firm flesh, good taste, soft flesh and non-fibrous content.

Although the project did not include pest and disease resistance as selection criteria, virus infection emerged as a significant factor reducing yields. Virus loads were much higher than anticipated.

"We have realised that this is an area that may be limiting sweet potato production and could open up a new area of work in future," Mr Treagust says. "Yields of sweet potato may be high to begin with—up to 30 tonnes a hectare—but decrease over time to a more average 6 t/ha as the virus load builds up."

Although yield performance has not been as great as hoped—early results indicate the highest yielding variety produces about 15 t/ha—the social impact of the project remains high, demonstrated by more than 2,000 farmers wanting to receive planting material.

Ms Ivahupa believes one of the reasons for the project's success was the combined focus on research and extension through on-farm field trials. "We were doing research and at the same time we were disseminating planting materials and information to farmers," she says. "We were taking research results directly to farmers, as the end users of the product, for them to make the selection instead of us."

The local preference is large tubers and two high-yielding varieties introduced from the Solomon Islands are attractive in this respect—a single tuber could weigh four kilograms.

The three-year project has been extended to November 2008 to allow planting material to be distributed. Nearly 800 farmers have received planting material from the project and another 1,400 have subsequently received material from these farmers.

Ms Ivahupa says the impacts of a greater supply of sweet potato will be felt in a number of ways. Of the 14 varieties, three orange-fleshed ones provide a valuable source of beta-carotene. Even though one of these is late-maturing and low-yielding, farmers want to keep it now that they know its nutritional benefits.

"You will see more sweet potatoes sold at roadside markets and fresh food markets in urban areas," Ms Ivahupa says. "In places where sweet potato is not a dominant staple, more will be sold and the smaller tubers fed to pigs."

The project included an activity where women were trained to prepare sweet potato in different ways. Now there is a booming cottage industry with mothers preparing and then selling these products at schools during lunch and recess breaks. ■

'Woman's crop' leads to other benefits

In Papua New Guinea, sweet potato is often referred to as a 'woman's crop' because it is easy to grow and fast to cook. A spin-off benefit of the new higher yielding varieties now being grown in Madang province is the opportunity for women to generate income from selling surplus produce.

World Vision paid the women for preparing the land, looking after the trial sites and harvesting the crop. With this money a bank account was opened for the women's group, to which they added the money from selling surplus tubers.

As a result of the project, a women's group in Nubia, Bogea District, saved enough money to set up a small trade store where they sell basic supplies such as soap, salt, tinned fish and rice, which previously could only be obtained by making a 300-kilometre trip to Madang. They have a committee to manage the store and replenish supplies.

"It shows they can make money from sweet potato and run their own business," Sharryl Ivahupa says.

Ms Ivahupa says the project has clearly helped women in the provinces. "The men are more interested in money-making crops, like copra, coffee, cocoa and vanilla, but when you talk about food crops that will end up on the kitchen table, it's the women who are interested because they want to know how best they can feed their families with fast and nutritious food."

The project involved many women's groups and helped to form new groups. The team helped the groups open passbook accounts, which is not an easy process for village women.

"The bank will ask you for an ID card, but village women do not have ID cards or passports. So we wrote letters to confirm they worked with World Vision," she says.

Community work a satisfying endeavour

Sharryl Ivahupa's warm voice on the phone conveys her sense of accomplishment about the World Vision project.

"The work I did in this project is what I really like doing—working with people in rural communities, introducing technologies and helping them adapt the technology," she says. "You find that people in rural communities are more ready and willing to take risks by accepting new technologies than the people who are closer to urban areas."

Program manager of the World Vision farmer evaluation project, Sharryl Ivahupa.

Although she lives and works in Madang, Ms Ivahupa is originally from Oro province north of Port Moresby, on the other side of the Owen Stanley Range, where the famous Kokoda Trail begins.

After completing a Bachelor of Science in Agriculture at the University of Technology in Lae, Ms Ivahupa started working as an agronomist for the PNG Department of Agriculture and Livestock. There she became involved in her first ACIAR project, investigating nutrient deficiency symptoms of tropical root crops. This led to her coming to Australia to complete a Masters in Agricultural Science at the University of Queensland with the support of an AusAID scholarship.

When she returned to PNG, Ms Ivahupa worked on another ACIAR project on planning for agricultural development and sustainable land management. She trained NARI and Division of Agriculture staff on the use and interpretation of the database as well as preparing a training manual on it.

Before joining World Vision, Ms Ivahupa worked as program director for Conservation Melanesia, a local environment and conservation NGO, where one of her tasks was to assess the impact of industrial logging and large-scale oil palm production on rural communities, and plan actions to minimise negative impacts.

She hopes to continue working with rural communities, introducing new technologies to improve their lives, and helping them adapt the technology to suit their situations.

Rare genetic find delivers high-quality sandalwood oil

Sandalwood plantations that exploit genetically superior stocks could help to meet the growing global demand for the precious commodity, while generating a much-needed cash income for local communities in Vanuatu and Cape York Peninsula

BY SAMANTHA MURRAY

For centuries, 'wooden gold'—sandalwood—has been cherished for its aromatic and therapeutic qualities. From Indian joss sticks to French perfume, the myriad cross-cultural uses of sandalwood may be surprising, but demand for sandalwood and its precious oil has led to a global shortage.

Concerned about the impact of over-harvesting as a result of growing demand, the Vanuatu Department of Forests approached ACIAR for assistance to understand the genetic diversity in sandalwood populations that affects oil production. In partnership with Australian researchers, the ACIAR-supported study made a remarkable discovery that is helping to boost production in ways that promote conservation efforts.

The ACIAR partnership found that for the sandalwood species in Vanuatu and Australia's Cape York Peninsula, about 3–4% of trees in local populations produce very high quality oil. To take advantage of the genetic potential of these species, communities are being helped to implement breeding programs and conservation strategies that will build viable sandalwood industries that exploit the international shortage.

Sandalwood is a medium-sized hemiparasitic tree that can grow independently or by drawing nutrients from a host. It grows mostly in tropical countries, including India, Indonesia, Australia and the Pacific islands.

In Vanuatu, sandalwood export revolves around the local variety, *Santalum austrocaledonicum*, which contributes a substantial proportion of the country's forestry revenue. About half of Vanuatu's sandalwood is sent as powder to China and Taiwan for making incense, while the other half is exported as oil to Europe for use in perfume and cosmetics. However, lack of information and poor management techniques have threatened to deplete Vanuatu's wild stocks and compromised overall sandalwood quality.

As a principal forest officer with the Vanuatu Department of Forests, Hanington Tate is familiar with the problem. He has been instrumental in developing the national sandalwood policy that aims to improve management of the natural stock and build a sustainable industry.

"Sandalwood is a small tree crop that fits well with traditional farming systems, so everybody feels it is an important cash crop that needs to be promoted for planting by rural communities," he says.

Included in the policy reforms is a requirement for the harvested sandalwood to be processed locally before export. It was as a result of this reform that Mr Tate made an important decision. After being informed by the distillery of variable oil yields, he came up with the idea of investigating genetic variability among natural sandalwood populations in Vanuatu.

He contacted ACIAR with the idea and was encouraged to jointly develop a project proposal with Australia's Dr Tony Page from James Cook University (JCU). When the project received funding, Mr Tate took on the role of in-country project leader.

At the project's outset, a series of workshops brought together Australian and Vanuatu collaborators—including local community members in both countries—to map the ensuing domestication and conservation programs. A survey of wild sandalwood stocks was undertaken, which identified the superior populations of the local species and the barriers to local communities managing this resource.

The surveys were conducted in regions

Sandalwood seedlings in a village nursery in west-coast Santo.

PARTNER COUNTRY: Vanuatu

PROJECT DESCRIPTION: FST/2002/097: Identification of optimum genetic resources for establishment of local species of sandalwood for plantations and agroforests in Vanuatu and Cape York Peninsula

CONTACT: Dr Tony Page, tony.page@jcu.edu.au

Sandalwood growers in Vanuatu range from small garden plantings to smallholder plantings of up to four hectares.

of known sandalwood populations on seven islands: Santo, Malekula, Moso (a small island north-west of Efate), Erromango, Aniwa, Tanna and Aneityum. They involved collecting several hundred woodcore samples from the superior tree populations. Oil quality of the samples was assessed and material from the trees was grafted onto rootstock in a centralised nursery at the Vanuatu Department of Forests in Port Vila.

Dr Tony Page, a research fellow from JCU's School of Marine and Tropical Biology, says the superior oil quality was identified by assessing the commercially important oil constituents—particularly the alpha-santalols and beta-santalols—against the international standard, which is based on the common Indian sandalwood (*S. album*).

Despite the important discovery, Dr Page was wary of the 'cash crop hype'. He offers copra as an example of the kind of development he was keen to avoid. By the time smallholders planted the copra crops, the value had already gone out of the market. However, he says that sandalwood—with increasing international demand and diminishing supplies—is a much safer option for the people of Vanuatu.

"This is a product that the ni-Vanuatu (indigenous population) are comfortable with, since it is part of their day-to-day existence and fits with their traditional agricultural practices," Dr Page says.

"Given the high value of sandalwood, villagers do not need to plant trees on a large scale like intensive cash crops. With raw sandalwood selling at approximately $10 a kilo, the cash goes a long way to helping them access the services Australians take for granted, such as schooling, medical services and travel."

Sandalwood growers in Vanuatu range from small garden plantings, of between 5 and 10 trees, to smallholder plantings of 1–4 hectares. Even a family with a small garden that plants 20 trees each year would be well on their way to building a sustainable and profitable plantation.

The Vanuatu Department of Forests (VDoF) aims to replicate the grafted seed orchard cultivated in Port Vila across Vanuatu. This will provide smallholders on several islands with seed sources from which they can establish plantations, which will ultimately help to protect wild populations from over-harvesting.

The project's conservation program recognises that sandalwood populations on the northern islands are genetically distinct from those on the southern islands. To maintain their genetic diversity and distinctiveness, the project has two separate seed production programs to preserve the differences between the north and south, while simultaneously managing each population in order to avoid the deleterious effects of future inbreeding.

An equally important project stream is education, with VDoF and JCU running a workshop to share their findings and teach the communities about propagation and silviculture. The workshop was attended by approximately 15 farmers, one from each participating community. Dr Page says the attendees were the more progressive farmers who could be relied on to take the information back to their communities.

"We found that the information did get disseminated between the villages and that nursery and silviculture techniques, such as the role of a host tree, made a significant impact," Dr Page says. "The next step would be to deliver training in the actual villages to reach even more people."

The Vanuatu Department of Forests and JCU are now filling in some of the knowledge gaps, looking at growth rates to determine actual producer returns. In the future Vanuatu will need to consider the different sandalwood markets and how Vanuatu's industry could position itself as a premium brand to the international marketplace. There is also likely to be opportunities for plantings of the joint venture investment type in collaboration with smallholder producers in Vanuatu.

"The project has been well received in Vanuatu," Mr Tate says. "Unlike a few forestry projects, this one jumps a few steps ahead by identifying the best available resource for germplasm improvement, bypassing the need for extensive trials. Resource owners like the project because it actually informs them of the quality of their sandalwood stands."

In contrast, in Australia a different sandalwood species, *S. lanceolatum*, has traditionally been valued by Aboriginal communities on Cape York Peninsula for oil, food, fibre and medicinal purposes.

One of the most exciting aspects of the Cape York studies was the discovery of an extremely high quality oil product. The studies indicated that the oil from some Cape York samples exhibits high concentrations of alpha-santalols and beta-santalols, and many of them meet international standard requirements. The result was most unexpected given that *S. lanceolatum* is considered the lowest quality of all sandalwood.

The scientific information offers the potential for the domestication of high-quality, drought-tolerant sandalwood by Indigenous communities in Far North Queensland, with the data serving as a platform to propagate the valuable strains in plantations and agroforests. ■

Putting food in bowls

Australian scientists participating in ACIAR's Seeds of Life project discuss their experience in East Timor

BY GIO BRAIDOTTI

For many Australian members of the joint ACIAR–AusAID-funded Seeds of Life (SoL) team in East Timor, the project is fulfilling a long-standing desire to engage with the developing world and share with its people knowledge that can lead to food security. Program leader Rob Williams calls it "putting food in bowls".

He describes his five years based full-time in East Timor as "living the dream", for it happens that agricultural aid combines two of his great passions in life: a need to mediate against the brutality of the world's food poverty and a love of green, growing things … some of which happen to be edible.

"I can remember as a child being fascinated by green things," he says, recalling an early botany experiment he ran in the backyard to prove to his father that peanuts really do grow underground. "As a teenager, questioning what direction to take, I realised that aid to developing countries was my passion and the way to achieve that dream was through agricultural science."

He enrolled at the University of Queensland in 1981 and went on to specialise in plant breeding and crop physiology. On campus, he met Catharina van Klinken, the woman he would marry upon graduating in 1987. Of the pair, it was Catharina who blazed the move to East Timor when in 1999 she became involved with the United Nations-sponsored referendum that delivered independence to the East Timorese. A linguist, Dr Williams-van Klinken has since written a grammar and course book for learning Tetun, the newly official language of independent East Timor.

In 2002, Mr Williams left behind a career as an agricultural scientist to New South Wales's rice farmers to join his wife in Dili. He was immediately recruited by ACIAR to help rehabilitate the agriculture faculty at the National University of East Timor.

"In 1999 most of the technical expertise left the country, stranding it with a huge vacuum at all levels of research, training and management," he says. "SoL got underway in 2000, with Brian Palmer and Brian Monaghan setting up the means to improve crop varieties, but even back then there was a focus on training and rebuilding technical expertise."

Projects such as SoL are designed like a four-dimensional jigsaw puzzle that, over time, add new layers of infrastructure, each a platform for further gains and improvements to the nation's farming capacity. The task in the earliest stages can seem daunting.

Brian Monaghan was on the ground in those early years with Brian Palmer, building a network of research stations to improve locally adapted varieties and for long-term agricultural R&D efforts.

His first base was a 60-hectare plot in Betano, which once housed a government station dating from Portuguese times. It was destroyed in 1999. He devised the layout of the new station and the plans for the buildings, laboratories and the research farm that now operates over 20 ha. The set-up is geared for the evaluation of new varieties and bulking seed, but there are also livestock facilities.

"When I arrived there was nothing; no buildings, just four local farmers and me," Mr Monaghan says. "Initially my office was under the shade of a tree and on the motorbike; then I worked out of the car. Now we have an operational research station, with a generator, and a staff of 15."

An agricultural scientist and farmer who grew up on a sheep and wheat property in Victoria, Mr Monaghan originally arrived as a volunteer with Australian Volunteers International (AVI). He married a Timorese woman and they now have a three-year-old daughter and nine-month-old son and are living in Same, four hours from Dili.

"You would never believe it now, but originally I had to be talked into going to East Timor," he says. "I'd previously spent time in Botswana and I was on my way back to Africa. East Timor was meant to be a minor detour. That was seven years ago."

Mr Monaghan is not the only team member whose involvement with SoL began through volunteering with AVI. Rebecca Andersen saw her initial stint with AVI cut short in May 2006 when gang-related violence caused the shutdown of Dili. On her return to Melbourne she looked for work, but acutely felt the disconnection from East Timor. Through a chance encounter with Rob Williams she learned that ACIAR was sponsoring curriculum improvement at the National University of East Timor, and she volunteered immediately to work with the SoL team.

An energetic 26-year-old, Ms Andersen put her horticultural science degree to good use at the university in Dili for 10 months, working with the agricultural department's lecturers, researchers and students. She has since been offered a position as research and extension adviser and is now working outside Dili in the northern districts, liaising between research stations and farm trial sites.

The Australians all speak Tetun. With the help of his three-year-old daughter, Sarah, Mr Monaghan is also learning the local dialect of his district, something other team members also aspire to since it facilitates communication with farmers.

"I'm mainly working with staff at the research stations or directly with farmers," Ms Andersen says. "We are getting information out about the new varieties, how to grow them, and monitoring the field trials. I rely on a four-wheel drive to get around. The going is rough, with bad roads and river crossings. But it is beautiful country, full of interesting people, and there is so much that needs to be done."

Since 2005, when SoL entered the on-farm trial phase, with Mr Williams as Australian program leader, the SoL extension team—which includes 24 newly fledged East Timorese graduates from the National University—has been running small packets of seeds out to villages across the country for testing.

"The willingness of farmers to try the new varieties has generally been quite good," Mr Williams says. "In some places we did get laughed out of town, at least initially. It was the volume of seed. It was so small. But the idea was for farmers to help test the new varieties and then bulk up the best varieties and distribute seed to family, friends and neighbours themselves. Now that the new varieties have proven themselves, everybody wants seed!"

There are downsides to the job—bad roads, repeated bouts of dengue fever and power outages spring readily to the minds of several team members—but somehow the overall experience remains vitally, even passionately, positive. In turn, team members report that local communities are happy to have the agricultural R&D activity and the Australian contribution is welcome.

One of the most prominent indicators that the aid action is having an impact is that it now takes less land to produce enough food to support a family. "With the farmers, we now talk about what to do with the extra yield," Ms Andersen says. "They had not considered the possibility of planting a cash crop."

With forward progress, another set of limiting factors comes to the fore, and the project responds by implementing the next layer of infrastructure. Mr Monaghan says the next limitations looming for farming in East Timor are labour, a need for roads and markets, and pressure on the land from population growth.

"The realistic view of agricultural development is that it takes a long time to get results," he says. "You need to build reliable information about the agricultural situation, recalling that, on farms, no two years are the same, and even five-year blocks are never alike. The farmers need options. There is a fair way to go, but the people here can do it." ■

Left: Rebecca Andersen at a farmers' field day in Liquica district.
Below: Rob Williams (second from left) at the National University of East Timor.

Prime Minister opens new aquaculture facility in Aceh

During his June 2008 visit to Indonesia the Prime Minister met staff working at the Australian embassy in Jakarta. Pictured is Mr Rudd (third from left) with country office staff; Ms Mirah Nuryati (assistant manager), Ms Wina Ludwina (office assistant) and Mr Julien de Meyer (manager).

The Prime Minister of Australia Mr Kevin Rudd, together with the Governor of Aceh province, officially opened the Regional Brackish-water Aquaculture Development Centre, at Ujung Batee, in Indonesia's Banda Aceh province, on 14 June 2008.

Redevelopment of the centre, devastated in the December 2004 tsunami, has been undertaken through a joint AusAID–ACIAR initiative. Prior to the tsunami, aquaculture was an important income source in Aceh but it was one of the sectors hardest hit by the tsunami and has struggled to recover. Half of all brackish-water aquaculture ponds were destroyed with another 12% so badly damaged as to halt production; 87% of all shrimp hatcheries were also destroyed. More than 40,000 people were affected, losing all or part of their livelihood.

Mr Rudd described the rebuilt centre as a centrepiece in the effort to increase economic opportunities and livelihoods for Acehnese people. He also praised the efforts of Australia's aid program in Aceh: "Australia's substantial longer-term commitment to Aceh is an integral part of our development partnership with Indonesia, which focuses on the 100 million people across Indonesia who live in poverty on less than US$2 a day."

Restoring aquaculture production meant rebuilding the infrastructure to support the industry, including the aquaculture centre that is needed to help farmers adapt to the post-tsunami environment. It is also important to relieve pressure on wild-capture fisheries in surrounding waters, which have been harmed by pollution and unsustainable long-term net fishing too close to reefs.

The AusAID–ACIAR partnership was established under the Australia–Indonesia Partnership. AusAID focused on rebuilding the devastated centre and ACIAR, in collaboration with a wide range of agencies and NGOs, focused on building the scientific capacity to run the centre, including training of staff to deliver better management practices for coastal aquaculture.

Training in aquatic disease detection systems, such as PCR (polymerase chain reaction) testing, has also been undertaken, with further activities planned including seed production technologies. The training has been led by James Cook University's Professor Paul Southgate, with Dr Mike Rimmer leading the on-the-ground training while living in Aceh.

Annual Operational Plan released

Details of ACIAR programs, priorities and performance goals for 2008–09 have now been released through the ACIAR Annual Operational Plan 2008-09 (AOP).

For 2008–09, ACIAR programs will focus around:

- fostering the development and production of new crop varieties with higher yields and more effective use of available water resources;
- developing crop rotation systems that enable a second crop to be produced on the same land each season;
- improving the efficiency of water and soil nutrient use in rainfed and irrigated areas;
- integrating livestock and aquaculture production with cropping systems to help meet the increasing demand for animal protein and farm diversification;
- enhancing smallholder incomes particularly in horticulture; and
- facilitating more appropriate domestic and international agricultural policy frameworks that encourage sustainable broad-based economic growth, productivity gains and associated food security.

Priorities are set for each partner country in which ACIAR will operate in 2008–09. These are grouped by themes, with subprograms, reflecting the mutually agreed priorities emerging from consultations between ACIAR and its partners. **The AOP can be downloaded from the ACIAR website at www.aciar.gov.au/publication/AOP2008-09. Hard copies are also available on request (see contact details page 2).**

Philippines projects add value

ACIAR has signed a Memorandum of Subsidiary Understanding with the Philippines Government to begin two projects that aim to deliver improvements throughout the fruit and vegetable value chains by targeting research to address barriers to increased production.

Each project is divided into six components, across a number of research disciplines. For example, in the fruit project four components will focus on barriers to increased production of a particular fruit crop, such as mango or papaya, with the fifth component examining the economics by measuring the profitability of new technologies emerging from the research, in conjunction with the underlying policy framework. Where appropriate, the linkages between

components will be identified and integrated into adoption and extension strategies.

The two projects represent a shift in design and delivery of ACIAR research initiatives, with the implementation of larger, more integrated and multidisciplinary programs.

At a ceremony in the Philippines, Australian Ambassador to the Philippines, Rod Smith, signed the project agreement with Dr Patricio Faylon of the Philippine Council for Agriculture, Forestry and Natural Resources and Development.

Speaking at the signing, Ambassador Smith said the project further cemented the partnership between the two countries. "On behalf of the Australian Government, I am pleased to note the long-standing collaboration of Filipino and Australian researchers in the development and improvement of new and existing technologies for various vegetables and fruit commodities."

Mr Ernesto H. De Leon, the Philippines Ambassador to Australia, was guest of honour at a dinner held as part of a project workshop in Canberra, to commence the projects. In his speech, Mr De Leon cited the global food crisis as further evidence of the need for projects that lift agricultural productivity.

"Recent developments put this launch of the ACIAR Philippines Fruit and Vegetable Program in the much broader context of world food security. Given the disturbing and sudden developments these past weeks regarding a world food crisis, I cannot help but be struck by the prescience of the ACIAR programs, which have been at the core of Australian development assistance to the Philippines."

Parliamentary Secretary visits East Timor

Australia's Parliamentary Secretary for International Development Assistance, Mr Bob McMullan, visited East Timor on 7–11 May 2008. During his visit Mr McMullan met with the Prime Minister Mr Xanana Gusmao and other ministers and senior officials in the East Timorese Government, to discuss Australia's development assistance program.

These discussions included a visit to ACIAR's Seeds of Life project. Mr McMullan met with members of the project team and farmers who are working to rebuild agriculture in East Timor by evaluating and selecting improved crop varieties. Mr McMullan visited trial plots and spoke with local farmers and extension staff involved in the adoption of improved varieties and management practices.

Setting priorities in Papua New Guinea

A series of high-level consultations between Australian and Papua New Guinea (PNG) stakeholders were held in May to set priorities for collaborative agricultural research for development. Participants included representatives from ACIAR and AusAID and representatives from relevant PNG national and provincial government departments, statutory authorities, research organisations, the Rural Industries Council, NGOs and the private sector.

In PNG, the consultations were

Mr Bob McMullan (second from right) in East Timor with participants in the Seeds of Life project, including project leader Rob Williams (second from left) and East Timorese participants Tiu Mateus, Tia Rejina and Basilio Pirres.

Parliamentary Secretary Mr Bob McMullan, with Seeds of Life's Rob Williams, examines sweet potatoes grown as part of the project.

Australian Ambassador to the Philippines Rod Smith (right) and Dr Patricio Faylon (left) of the Philippine Council for Agriculture, Forestry and Natural Resources and Development signing the Memorandum of Subsidiary Understanding.

Mr Ernesto H. De Leon (right), the Philippines Ambassador to Australia, with ACIAR CEO Mr Peter Core, at the project workshop in Canberra.

conducted as part of ACIAR's formal program of high-level meetings with leading PNG researchers and other stakeholders, to identify a set of key issues and priorities as a framework for the design of collaborative research projects. The key themes agreed on through the consultations were:

- addressing social, cultural and policy constraints to the adoption of agricultural technologies
- enhancement of smallholder incomes from horticulture and root crops
- improving smallholder returns from export tree crop production and marketing
- new livelihoods from smallholder fisheries, aquaculture and forestry
- sustainable management of forestry and fisheries resources, and agricultural biosecurity.

All research programs will specifically address the social, cultural and policy constraints to adoption of agricultural technologies and include major components on institutional and individual capacity building.

For more details on the priorities in PNG visit: www.aciar.gov.au/node/8982

South central coast focus for Vietnam–Australia consultations

A joint Vietnamese–Australian workshop was held in Quy Nhon, Binh Dinh province, on 3–5 March 2008 to discuss priorities for collaborative agricultural research in the south central coastal provinces of Vietnam.

Participants included representatives from ACIAR and AusAID, Vietnamese Ministry of Agriculture and Rural Development, a number of Vietnamese R&D institutes, agriculture departments and universities, and NGOs and other donors.

The workshop was conducted in light of a 2007 agreement with the Ministries of Agriculture and Rural Development, and Planning and Investment, that there would be an increased focus on two regions: the south central coast and the north-west highlands.

The priorities determined during this workshop will be used by ACIAR as a framework for collaborative research for development activities over the next four years, subject to further advice and information from Vietnam.

It was agreed that the focus for the program would be on more profitable, but sustainable, crop cultivation integrated with beef cattle production systems in the challenging environment of south central coastal Vietnam where soils are often poor and sandy, and dry seasons are long. Research themes will include soils and water, livestock , horticulture and cash crops, and agribusiness and extension.

For more information on priorities for south central coastal Vietnam visit: www.aciar.gov.au/node/8470

Understanding the world food crisis

A group of Australians with international agriculture and development experience have been appointed to a national taskforce to address the causes of rising world food prices and food shortages, and seek solutions to this crisis. Recent rises in world food prices have resulted in as many as 100 million people slipping back into poverty.

The role of the taskforce, formed by the ATSE Crawford Fund, is to provide an independent perspective on the complexities driving up food prices, and to deliver a set of specific proposals that could be actioned. These actions will focus on an Australian context, especially in terms of the Australian aid program.

Parliamentary Secretary for International Development Assistance, Mr Bob McMullan, has welcomed the establishment of the taskforce as an independent source of information on the causes of rising world food prices and their impact on the world's impoverished people.

Hunger in developing countries, where most of the world's poor live—those earning less than US$1 a day—is growing as a result of rising food prices. In developing countries that are net food importers, food accounts for 70% of household expenditure. The rising cost of food has made it harder for those living close to the poverty line to survive, with their real income falling as they absorb food price rises. The World Bank estimates that the erosion in real income has seen between 73 and 105 million people in developing countries fall below the poverty line, a trend likely to accelerate if prices continue to rise.

The taskforce will address what can be done on a practical basis to stop this trend by drawing together the range of issues, and testing these within the context of the Asia–Pacific region. Mr J.C. Ingram AO, a former head of AusAID and Executive Director of the UN's World Food Programme, will lead the taskforce.

Several members have strong links to ACIAR. Professor Beth Woods is the current president of the ACIAR Policy Advisory Council, while Dr Gabrielle Persley and Dr Tony Fischer have both served as research program managers at ACIAR.

For information on the food crisis, visit ACIAR's website at www.aciar.gov.au/node/8549. For information about the taskforce, visit www.aciar.gov.au/node/9043

NEW APPOINTMENTS

Dr Doug Gray is ACIAR's new research program manager for Animal Health. Doug has a PhD in Parasitology and a Bachelor of Science (Hons) from the University of Glasgow. Prior to joining ACIAR, Doug worked as a private consultant before which he led the Asian programs of the International Livestock Research Institute. He has also worked as a principal research scientist for CSIRO and as a senior lecturer at the University of New England. He has worked with ACIAR as a project leader, reviewer and as an editor of ACIAR monographs.

Mr Julien de Meyer has been appointed ACIAR's country manager for Indonesia, based in Jakarta. Julien has experience in agricultural R&D, having managed the consultancy company Effective Development Group, which monitored research and development projects. He has worked for the International Wheat and Maize Improvement Centre in Africa and Mexico and began his career working in agricultural development in the Philippines and Africa. Julien is a Masters Graduate and University Medallist from the Swiss Federal Institute of Technology.

NEW PUBLICATIONS

CORPORATE PUBLICATIONS

• Annual Operational Plan 2008–09 ACIAR's Annual Operational Plan 2008–09 outlines the centre's research priorities for each partner country for the financial year. *June 2008.*

• Adoption of ACIAR project outputs: studies of projects completed in 2003–2004 Adoption studies are undertaken three to four years after a large project is completed to assess the level of uptake and the legacy of the project. This adoption study looks at projects completed in 2003–04.

MONOGRAPHS

• Guidelines for surveillance for plant pests in Asia and the Pacific (Thai translation) The Thai translation of Monograph 119 aims to assist plant health scientists to devise surveillance programs and to transmit specimens to the laboratory for identification and preservation. *Teresa McMaugh, Thai translation by Yupa Hanboonsong, 2008, ACIAR Monograph 119c, 199 pp. $55 GST inclusive (plus postage and handling).*

• Better-practice approaches for culture-based fisheries development in Asia (Lao translation) The Lao translation of Monograph 120 provides guidance to development workers and program planners for integrating community-based fisheries into rural development plans. *Sena S. De Silva, Upali S. Amarasinghe and Thuy T.T. Nguyen, 2008, ACIAR Monograph 120a, 105 pp.*

• Better-practice approaches for culture-based fisheries development in Asia (Vietnamese translation) The Vietnamese translation of Monograph 120 provides guidance to development workers and program planners for integrating community-based fisheries into rural development plans. *Sena S. De Silva, Upali S. Amarasinghe and Thuy T.T. Nguyen, 2008, ACIAR Monograph 120b, 96 pp.*

•Diagnostic manual for plant diseases in Vietnam Plant diseases continue to cause significant crop losses in Vietnam and other regions of tropical South-East Asia, particularly for smallholders growing valuable cash crops. This manual is designed to help plant pathologists develop basic skills in the diagnosis of the cause of diseases, focusing on fungal diseases of the roots and stems. *Lester W. Burgess, Timothy E. Knight, Len Tesoriero and Hien Thuy Phan, 2008, ACIAR Monograph 129, 210 pp.*

• Soil Constraints and Management Package (SCAMP): guidelines for sustainable management of tropical upland soils This book describes a decision-support framework called the Soil Constraints and Management Package (SCAMP), designed to bridge the gap between taxonomic soil surveys and informed management strategies for sustainable production on upland soils in the tropics. Being simplistic yet comprehensive, it can be applied to any upland situation. *P.W. Moody and P.T. Cong, 2008, ACIAR Monograph 130, 85 pp.*

• Integrated pest and disease management for sustainable cocoa production: a training manual for farmers and extension workers This booklet addresses knowledge gaps in cocoa production. New management approaches, based on sound agronomic practices and integrated pest and disease management strategies, have been developed to assist farmers to optimise their cocoa production. Farmers can expect significantly higher yields if these approaches are implemented completely and correctly. *John Konam, Yak Namaliu, Rosalie Daniel and David Guest, 2008, ACIAR Monograph 131, 36 pp.*

• TaroPest: an illustrated guide to pests and diseases of taro in the South Pacific Taro (*Colocasia esculente*), which is a major food crop in the South Pacific, is subject to significant losses from pests and diseases. *TaroPest*, a field guide and interactive CD-ROM, has been developed as a guide to the pests and diseases of taro in the South Pacific. *Amy Carmichael, Rob Harding, Grahame Jackson, Sarlesh Kumar, Sada Lal, Roy Masamdu, Jacqui Wright and Anthony Clarke, 2008, Monograph 132, 76 pp.*

• Overcoming liver fluke as a constraint to ruminant production in South-East Asia Liver fluke is an important internal parasite of ruminants. It debilitates livestock from a wide range of economically important species including cattle, buffalo, sheep and goats. This monograph addresses the knowledge gaps in the genetics, immunology, epidemiology and control of liver fluke disease. *G.D. Gray, R.S. Copland and D.B. Copeman (eds), 2008, ACIAR Monograph 133, 155 pp.*

PROCEEDINGS

• Permanent beds and rice-residue management for rice–wheat systems in the Indo-Gangetic Plain Rice–wheat cropping systems are critical for food security and livelihoods in South Asia, particularly in India where 10 million hectares of rice and wheat are grown in sequence, providing 85% of the total cereal production. The sustainability of these systems is now in question. This proceedings of a workshop held in Ludhiana, India, provides a comprehensive compilation of the experience in permanent raised beds and direct drilling into rice residues in the Indo-Gangetic Plain of South Asia. *Ed. by E. Humphreys and C.H. Roth, 2008, ACIAR Proceedings 127, 192 pp.*

TECHNICAL REPORTS

• Grassland degradation on the Tibetan Plateau: the role of small mammals and methods of control This publication looks at degradation of the grasslands of the Tibetan Plateau. It is particularly focused on monitoring and management of pika populations, small herbivorous mammals that are thought to play a significant role in the degradation. *Anthony D. Arthur, Roger P. Pech, Jiebu, Zhang Yanming and Lin Hui, 2007, ACIAR Technical Reports 67, 35 pp.*

• Economic potential of land-use change and forestry for carbon sequestration and poverty reduction Concerns over rising levels of greenhouse gas emissions have led to the establishment of markets to trade and also sequester carbon dioxide (CO_2). Tree-based systems are a convenient way of reducing net emissions by sequestering CO_2 from the atmosphere. The practicalities, policies and mechanisms for using smallholder agroforestry systems for carbon capture are explored in this publication including how smallholders compare with other landholders in terms of efficiency in sequestering carbon. *Oscar Cacho, Robyn Hean, Kirsfianti Ginoga, Russell Wise, Deden Djaenudin, Mega Lugina, Yuliana Wulan, Subarudi, Betha Lusiana, Meine van Noordwijk and Ni'matul Khasanah, 2008, ACIAR Technical Reports 68, 98 pp.*

• Achieving food security in China: implications of World Trade Organization accession China's accession to the World Trade Organization (WTO) in 2001, after 15 years of negotiations, was a momentous event for China and for the world economy. However, China's accession to the WTO did not have unanimous approval within the country. This report looks at the effect of China's WTO accession commitments on its agricultural sector. *Chunlai Chen and Ron Duncan, 2008, ACIAR Technical Reports 69, 67 pp.*

IMPACT ASSESSMENT SERIES

• Breeding and feeding pigs in Vietnam: assessment of capacity building and an update on impacts The study updates the estimates of the impact reported in IAS 17, with the total benefits from this research activity and subsequent follow-up activities revised substantially, from a net present value of benefits of nearly $500 million to nearly $2.0 billion. This provides a benefit-to-cost return of more than 250:1 and an internal rate of return of 74%. The capacity building included as an important component of the original project has been crucial in sustaining and extending the impact of the research. *Hayden Fisher and Jenny Gordon, 2008, ACIAR Impact Assessment Series 52, 56 pp.*

• The impact of increasing efficiency and productivity of ruminants in India by the use of protected-nutrient technology The dairy industry is a large and important sector for India and availability of quality feed is a significant issue for cow productivity. The ACIAR project assessed in this impact study focused on this major constraint and adapted some technologies readily available in Australia to suit the types of feed available

in India. The impact was shown to be substantial, with a benefit to cost ratio of 124:1. *M. Monck and D. Pearce, 2008, ACIAR Impact Assessment Series 53, 32 pp.*

WORKING PAPERS

• A survey of the mineral status of livestock in the Tibet Autonomous Region of China (Mandarin translation) This is the Mandarin translation of Working Paper 59, which details the outcome of a cooperative program that assessed the mineral and trace element status of yaks, cattle, horses and sheep from different environmental and management systems in Tibet Autonomous Region of China. *Nyima Tashi, Luo Xugang, Yu Shunxiang and Geoff Judson, 2008, ACIAR Working Paper 59a, 36 pp.*

PROJECT FINAL REPORTS

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• The potential for tropical fruits production in Tonga: a feasibility and constraints analysis *Patricia Chay, Yan Diczbalis, Victor O'Keefe, Rod Strahan, Viliami Kami, Lamipeti Havea, Tevita Tapaevalu, Alipate Tavo, 2008, ACIAR Final report HORT/2006/108, www.aciar.gov.au/node/8866*

• An inventory of wild sandalwood stocks in Vanuatu *David Gillieson, Tony Page, Jeffrey Silverman, 2008, ACIAR Final report FST/2006/118, www.aciar.gov.au/node/8439*

• Developing the ornamentals industry in the Pacific: an opportunity for income generation *Andrew M. McGregor, Kyle Stice, Aileen Burness, Mary Taylor, 2008, ACIAR Final report HORT/2006/055, www.aciar.gov.au/node/8484*

• Yam nutrition and soil fertility management in the Pacific *Jane O'Sullivan, James Ernest, Marie Melteras, Siosiua Halavatau, Philip Holzknecht and Jimmy Risimeri, 2008, ACIAR Final report SMCN/1998/028, www.aciar.gov.au/node/8448*

SOUTH-EAST ASIA

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• The potential for passionfruit in eastern Indonesia *Ian Baker, Zulkifli Razak, Philip Karundeng, 2008, ACIAR Final report SMAR/2007/197 Part 4, www.aciar.gov.au/node/8511*

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Back cover: An East Timor boy selling his family's ground nuts (peanuts) at a roadside stall.

Front cover: *Phaseolus vulagris* beans offered to a 'seed hunting' team during an expedition to remote areas of Armenia where they appear to have replaced the chickpea and lentil as the major source of vegetable protein. This has added interest for researchers because the beans were domesticated in the Americas whereas Armenia is the centre for chickpea and lentil. The question posed is 'where have the domesticated chickpea and lentil gone'? One scenario is the beans were introduced by Soviet farm advisers sometime after the 1920s and over the subsequent decades have supplanted chickpea and lentil—even in these crops' native region.

PHOTOS: BRAD COLLIS

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