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# partners

IN RESEARCH FOR DEVELOPMENT



## THE PHILIPPINES

The power of multi-disciplinary research

# THE PHILIPPINE PROGRAM



BY **AMANDA GORELY**

Australian Ambassador to the Philippines

The Philippines is an important partner for Australia in South-East Asia and we cooperate closely on a range of global and regional issues. More than partners, we are mates. We stand by each other in good times and in bad. Our ties were forged in the heat of battle—when Australian defence personnel fought side-by-side with Filipino and Allied forces in the liberation of the Philippines in World War II—and those ties grew stronger during peacetime.

Today, our relationship encompasses expanding trade and investment links; robust defence and law enforcement cooperation; and a significant development program valued at A\$85 million (3.2 billion Philippine pesos) focused on economic growth, education, social protection and, where necessary, humanitarian assistance.

An important linchpin to this development cooperation is ACIAR.

ACIAR opened its office in the Philippines in 1984, just one year after it was established as a statutory authority in Australia. Aligned with Australia's new aid paradigm, ACIAR has since its inception offered science and technology-based solutions to real-world problems of farmers and fishers in developing countries. Over 33 years, through 179 ACIAR projects, Australia has played a small, but strategic, role in the Philippines' growth.

Agriculture plays an important part in the Philippine economy. The Philippine Development Plan (PDP) 2017–22 highlights the role that expanded agricultural opportunities stand to

play in reducing social and economic inequality. Through ACIAR, Australia is working to help the Philippines reach its development goals through increased productivity and marketability of Filipino agricultural products.

An important agricultural sector for the Philippines is horticulture and the challenges that have impeded industry development for small-scale farmers.

From little things, big things grow. Today, ACIAR supports about 16 agricultural research projects in the Philippines—many of which are featured in this issue of *Partners*.

ACIAR's most significant research in the Philippines is helping to improve the production of high-value horticultural products. It is working with poor farmers to develop value chains and higher-earning routes to markets; it is enhancing opportunities for communities dependent on fisheries for their livelihoods; it is increasing the resilience of agriculture to climate change; and it is developing innovative tools for extension and technology transfer. ACIAR's current research collaboration in the Philippines is valued at A\$24 million (PHP930 million).

A tangible example of ACIAR's economic impact can be seen in the Philippine mango industry. The Philippines is the ninth-largest mango producer in the world, producing about 860,000 tonnes a year. When concerns over insect infestation restricted the export market for Philippine mangoes—including to Australia—ACIAR research assisted the Philippines, particularly Davao farmers, with vapour-heat treatments to address the risk of fruit flies. The same project also achieved important productivity gains and extension expertise.

In 2016, Australia signed an agreement with the Department of Agriculture to recognise the Philippines as pest-free for seed and pulp weevil, except for the Island of Palawan. The economic benefit for the Philippines of increased mango exports alone is worth millions. The successful partnership forged between Australian and Filipino researchers, farmers and government agencies is now helping farmers to develop new export markets. This is a testament to how Australia and

the Philippines can work together to mutually benefit from improving the region's biosecurity and market access.

ACIAR also structures its partnerships with the Philippines in ways that build national capacity for well-targeted, strategic agricultural research for development. ACIAR creates two-way learning channels that enhance the know-how of both Australian and Filipino research agencies. Together they generate a greater regional prosperity and capacity, especially with regards to biosecurity.

ACIAR works closely with the Department of Science and Technology, national research institutions, academia, local government divisions, civil society and the private sector. It also provides training and professional development opportunities for researchers in partner institutions. About 52 Filipino researchers have received scholarships to complete masters and doctoral studies at Australian universities. This upskilling includes management and leadership training for mid-career researchers that aims to build capacity in designing and implementing strategic research for development initiatives within partner institutions.

ACIAR also provides funding to the International Rice Research Institute (IRRI) that is based in the Laguna Province of the Philippines and undertakes world-class research to address extreme poverty by helping farmers grow more rice in environmentally sustainable ways.

I am proud that in the important field of agricultural research and development, Australia is making a meaningful and lasting contribution to help the Philippines achieve its vision of inclusive growth. ■

# PROVIDING SCIENCE SOLUTIONS



## BY DR REYNALDO EBORA

Acting Executive Director, Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD), Department of Science and Technology (DOST)

Tasked with providing a unified focus for the country's agricultural research since it was established in 1972, the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) has evolved into an apex research and development organisation. As the apex organisation for science and technology in the agriculture, aquatic and natural resources (AANR) sector, the council works with other agencies to focus their R&D initiatives on achieving desired outcomes. It also allocates government and external R&D funds.

PCAARRD forms partnerships with regional, national and international organisations, including ACIAR, which is a long-standing partner in research for development. Together, we have forged many mutually beneficial agricultural initiatives to improve the productivity, sustainability and resilience of agriculture and food systems in the Philippines and Australia.

Institutional building and co-learning forms the core of the PCAARRD–ACIAR partnership. ACIAR has a memorandum of understanding endorsing PCAARRD's role in monitoring ACIAR investments in the Philippines. It is a relationship that will continue to solve real-world problems into the future using science-based solutions, but with longer-term horizons.

In the next six months, PCAARRD will work

closely with ACIAR to develop a 10-year country strategy that identifies research priorities in the Philippines. The Philippine Harmonised National R&D Agenda for 2017–22—the country's road map for the AANR sector—will guide this planning process, which also involves integrating lessons from our previous collaborative projects.

Essential to this process of continuous improvement is the ability to assess the impact of research on smallholder farmers and communities from the adoption of research outputs.

For ACIAR, assessing impact has provided evidence that is used to account for R&D investments to stakeholders and to demonstrate the net benefits from projects. Further, the subsequent findings and lessons learned contribute to ACIAR's priority setting and the design and management of new ACIAR programs and projects.

Like ACIAR, PCAARRD has a keen interest in measuring the impact of research projects, exemplified by its published method for impact assessment, *Impact Assessment of Research, Development and Extension Projects in Agriculture: A Simplified Approach* (Tidon et al, 2016), which is generally consistent with ACIAR's impact assessment approach.

Both ACIAR and PCAARRD recognise that our research for development projects are becoming increasingly complex, multi or trans-disciplinary and occur in dynamic settings, requiring a more holistic, multidimensional approach to assessing livelihood, economic, social and environmental impact. In response, a new collaboration between ACIAR and PCAARRD will further develop, document and apply mixed-method approaches to impact assessment that capture and assess the scientific, economic, social, environmental, policy and capacity-building impact of agricultural research for development investments. The approaches will be applied to the impact assessment of jointly supported research projects in the Philippines.

A better understanding of the nature and extent of project impact will help both organisations inform future project design and improve project measurement and evaluation activities to target and track progress towards the desired outcomes of sustainable and resilient poverty alleviation. ■

**"OUR RESEARCH FOR DEVELOPMENT PROJECTS ARE BECOMING INCREASINGLY COMPLEX, MULTI OR TRANS-DISCIPLINARY AND OCCUR IN DYNAMIC SETTINGS, REQUIRING A MORE HOLISTIC, MULTIDIMENSIONAL APPROACH TO ASSESSING LIVELIHOOD, ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACT."**

– DR REYNALDO EBORA



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# FOCUS ON THE PHILIPPINES

In 1984, the Philippines became one of the first partner countries to host ACIAR projects. Today, the Philippines provides a wonderful example of ACIAR's partnership model in action.

The articles in this issue of *Partners* provide a rich cross-section of our research portfolio and demonstrate the power and value of ACIAR's combination of breadth of disciplines, depth of partnerships, and length of relationships to ensure impact over time.

As someone with a long history with Landcare in Australia, it is extremely satisfying for me to read stories about ACIAR investments in multidisciplinary research that highlight the importance of the social drivers of land use and management. In the southern Philippines in particular, in contexts characterised by high levels of poverty and conflict, several ACIAR projects are combining social and biophysical sciences in innovative ways to help smallholders improve their food security, their incomes, their livelihoods and the management of their natural resources. Projects are helping smallholders to work collectively to improve their access to higher-paying markets for vegetables and mangoes; to develop more socially aware approaches to reforestation for watershed rehabilitation; to produce new extension models drawing on landcare principles to improve social capital—all great examples of ACIAR multidisciplinary research partnerships between Australian and Filipino scientists and local communities.

Several articles underline that horticulture is a major strength of ACIAR's work in the Philippines. The horticulture program delivers important benefits to local communities, but also to the Australian horticulture sector. Richard Markham highlights how Australian scientists working on pests, diseases and integrated pest management (IPM) in fruit and vegetables in the Philippines have improved their own knowledge and built 'advance warning' capabilities of great value for the Australian banana, rockmelon and mango industries.

Innovation is another feature of our Philippines portfolio, exemplified by the University of Queensland invention of a new, safer and more convenient way to ripen fruit. The fascinating story on mass coral reseeded techniques developed through ACIAR work in the Philippines is another



**"THE ARTICLES IN THIS ISSUE OF PARTNERS PROVIDE A RICH CROSS-SECTION OF OUR RESEARCH PORTFOLIO AND DEMONSTRATE THE POWER AND VALUE OF ACIAR'S COMBINATION OF BREADTH OF DISCIPLINES, DEPTH OF PARTNERSHIPS, AND LENGTH OF RELATIONSHIPS TO ENSURE IMPACT OVER TIME."**

– ACIAR CEO Andrew Campbell

example, with potentially huge implications for the Great Barrier Reef.

Research funders ideally should be 'keepers of the long view' so that we can track our impacts through time, learn the lessons and hopefully not repeat past mistakes. Having good systems for managing a whole portfolio (including 'completed' projects) and a high level of staff continuity also enable the value of much earlier research to be highlighted.

The great story on giant clams is a wonderful example. ACIAR's work on giant clam aquaculture with Professor Edgardo Gomez more than 30 years ago is now delivering major benefits for the Philippines and Pacific countries in tourism, conservation, marine ecosystem health, community pride and the development of marine science capacity in the Philippines. These were not the intended outcomes of the original research project, but tracking impacts over subsequent decades has revealed a much richer story.

Understanding and assessing the impact of our investments on smallholders, communities and industries in our partner countries—impact that results from the adoption of research outputs by next users and final users—has long been vital for ACIAR. We use this work to learn from experience, to feed into the design of future programs and also to account for public expenditure. It is an interest we share with our lead partner in the Philippines, the Philippine Council for Agriculture, Aquatic and

Natural Resources Research and Development (PCAARRD). We recognise that research-for-development projects are becoming increasingly complex and simply measuring increases in farmers' gross margins per hectare rarely captures the full impact or value of such research projects.

It is a reflection of the relationship we have built with PCAARRD and the Philippines that we are able to collaborate to further develop mixed-methods approaches to impact assessment, with opportunities to extend these methods to other countries in the region.

In every way, the Philippines is an important partner country for ACIAR. We are proud of our long legacy of work in the Philippines, exemplified by the wonderful stories in this issue of *Partners*, and we look forward to working closely with PCAARRD and other Filipino partners for many years to come. ■

**PROFESSOR ANDREW CAMPBELL**  
CEO of ACIAR



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IN RESEARCH FOR DEVELOPMENT

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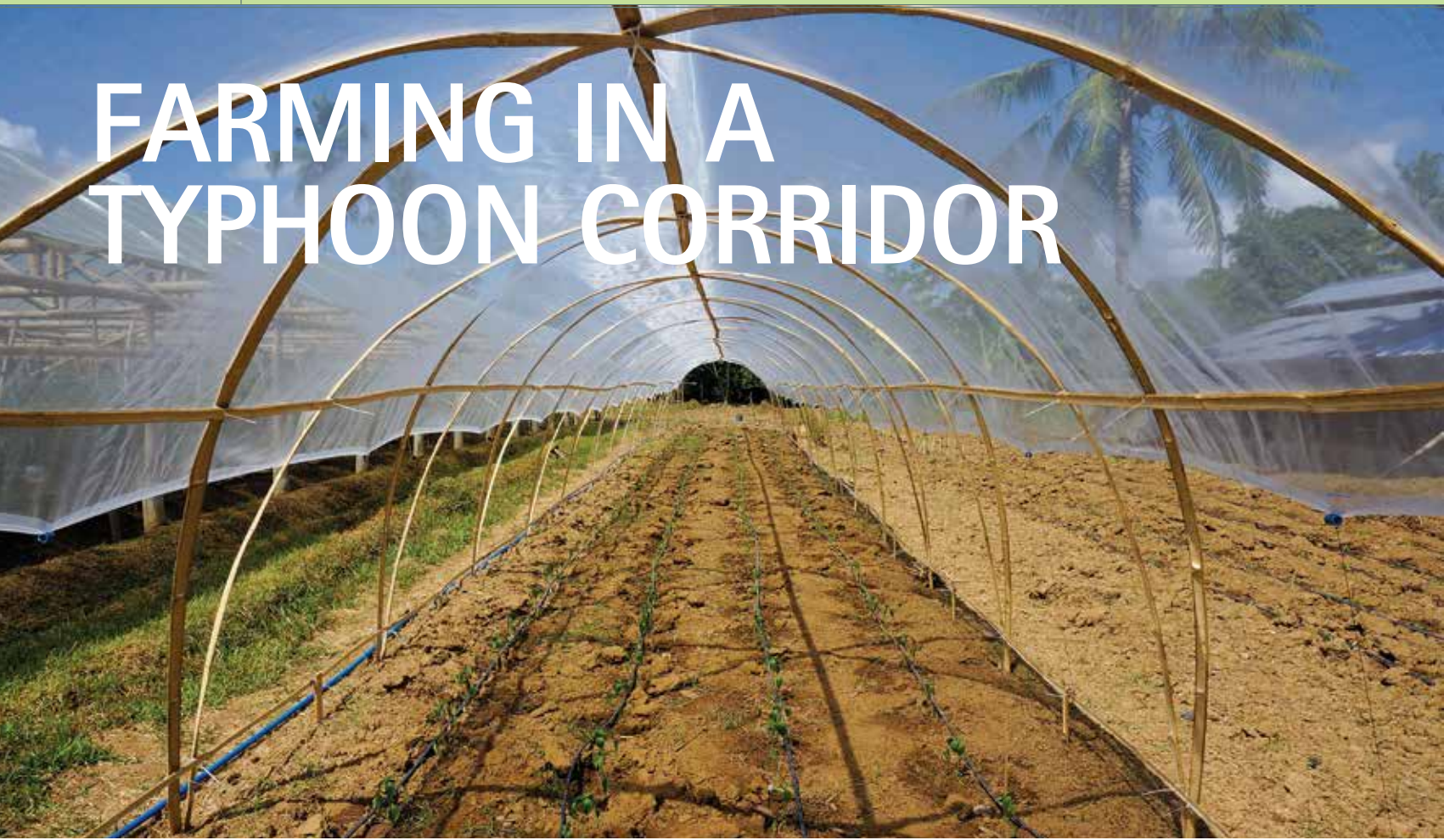
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FRONT COVER:

Mr Boie Gerona and Dr Zenaida Gonzaga are happy with the sweet pepper crop Boie produced in his protected cropping structure in Bontoc, Leyte.

PHOTO: Gordon Rogers

# FARMING IN A TYPHOON CORRIDOR



A low tunnel structure designed by farmers in Leyte using fine netting.

PHOTO: GORDON ROGERS

## Poor smallholder farmers in the Philippines' 'typhoon corridor' are working with Australian researchers to develop resilient farming methods to grow high-value vegetable crops

BY GIO BRAIDOTTI

**D**r Sandra McDougall describes the Philippines as a country of geo-climatic extremes. That description may verge on understatement, however, given the archipelago's status as the country with the second-highest risk of natural disasters in the world. While these risks include earthquakes, tsunamis and drought, they are all overshadowed by the annual occurrence of typhoons that traverse the country from the east within a 'typhoon corridor' that affects millions of people.

Among those severely affected each year are smallholder farmers whose livelihoods and food security are precariously dependent on the ability of farming systems to withstand extreme wind and rain damage that can strike up to 20 times a year.

Drawing on agricultural research capacity in Australia and the Philippines, ACIAR is funding research to improve the resilience and profitability of poor smallholder farms in regions prone to natural disasters.

The initiative targets vegetable production and

is evolving through three phases, starting with the development of innovative agricultural practices and culminating in the creation of profitable market linkages for the resulting 'accredited safe' vegetable produce (see story on page 14).

### BOOSTING FARM PROFITS

To explain the rationale behind targeting vegetables, Dr McDougall of the NSW Department of Primary Industries points to the plight of rice farmers following the devastation wrought by the largest typhoon to hit the Philippines—Typhoon Haiyan, known locally as Yolanda—which made landfall in the Leyte province on 8 November 2013 and affected ACIAR project sites.

"Rice farmers needed food quickly but they could not obtain seed or the fertiliser they needed," she says. "In contrast to rice, vegetables can be grown quickly and easily all year round, they are far more profitable than rice and they meet an important nutritional gap since the Philippines has one of the lowest vegetable consumption rates in the world.

"That was why we focused on vegetable production systems and why we took a holistic approach that encompassed production and profit challenges from farm to market."

The initiative got under way in 2009 in Leyte with trials to understand how best to protect vegetable crops from the extreme rainfall common in the centrally located Visayas region. Dr Gordon Rogers of Applied Horticultural Research explains that rainfall in the region can exceed two metres a year, resulting in massive waterlogging and disease risks for vegetable crops.

"The critical point is that the wet season coincides with high market prices for vegetables in the Philippines," he says. "To help smallholder

farmers access those price premiums we trialled low-cost crop protection structures that function as rain shelters. The trials were first held at Visayas State University and then in farmers' fields and identified two designs that consistently increase yields and quality, and at least double profitability, with the biggest return earned during the wet season."



Gordon Rogers

The first design is a simple house-like structure built from locally sourced bamboo that is covered in UV-resistant plastic. The second is a simpler low tunnel covered in either plastic or fine mesh netting. Both structures are open on the sides to allow for ventilation.

"Including labour costs, the houses cost about A\$800 to A\$1,000 to protect 250 square metres, while tunnels come in at about A\$200 for 60 square metres," Dr Rogers says. "They have a life of about five years and pay for themselves in under two years given the associated increase in gross margins from the sale of vegetables."

### BETTER AGRONOMY

During the second phase, which is nearing completion, project activities were expanded to the Samar and Bohol provinces. The project team rolled out the protected structures to more farmers, including 1,000 participating in season-long farmer field schools. ACIAR provides these farmers with inputs, such as seedling trays, seed, starting fertiliser and crop mulch, to maintain soil fertility under the more intensive cropping regime. These inputs allow farmers to replicate the field school lessons on their own land.

The project team also ran trials on a broader range of agronomic challenges, including pest and disease control issues, low-cost irrigation (especially in drought-prone regions in Samar) and improving seedling production systems. One of the challenges Dr McDougall faces is a government push for safe food that includes organic and biological pest management practices.

"The ACIAR project allowed us to run pest control evaluation trials for the home-brewed and biological pesticides recommended by the Department of Agriculture, such as wood vinegar," Dr McDougall says. "We found that organic products generally performed better than doing nothing, but usually did not perform as well as commercial insecticides."

Several strategies for reducing bacterial wilt damage to lucrative tomato and sweet pepper crops were identified during trials of disease and pest control strategies. Besides the benefit provided by rain shelters (by reducing soil moisture), techniques to graft tomatoes onto the hardier rootstocks of eggplants and the use of bed mulches were evaluated.

In another example, an insecticide based on the fungus *Metarhizium* was found to kill several sucking insects that can damage vegetable crops. Another biological product, based on the soil-dwelling bacterium *Bacillus thuringiensis* (or Bt), was found to be effective against caterpillars.

The agronomic research culminated in the recent production by the project team of best practice guides for six vegetable crops: tomatoes, eggplant, sweet pepper, bitter gourd (ampalaya),

water spinach (kangkong) and Chinese cabbage (pechay). These guides, along with integrated pest management guidelines, became available in local dialects in 2017.

To complement the research conducted in this project, a further project is addressing soil and crop nutrition limitations to vegetable crop production in the affected regions. This research is being conducted under project SMCN/2012/029, 'Soil and nutrient management strategies for improving tropical vegetable production in southern Philippines and Australia'. The project aims to identify soil and crop nutrient constraints for smallholder vegetable farmers in the southern Philippines and develop technologies, programs and strategies for cost-effective production of vegetables while sustaining the natural resource base. The project has undertaken a considerable soil and plant survey in the typhoon-affected area of Leyte to identify the key limitations to vegetable production as well as in Bohol, Northern Mindanao and Samar. This has shown that poor soil fertility manifested as low nutrient supply and availability, particularly in predominantly acidic soils, are key limitations along with excessive

**Below:** Mr Boie Gerona with the structure he designed to withstand strong winds and improve his farm's bottom line. **Bottom:** Farmer Albert Rosillio with his crop of bitter gourds at Baybay, Leyte.

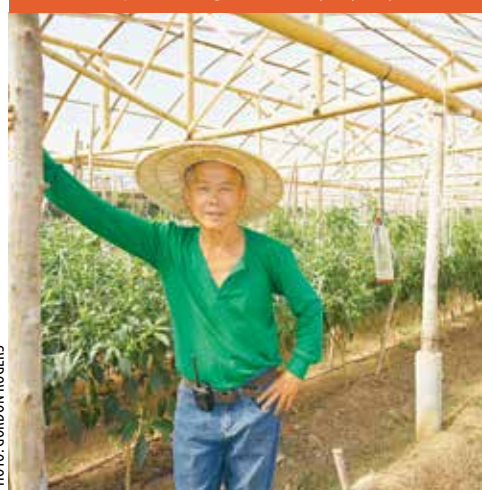


PHOTO: GORDON ROGERS



PHOTO COURTESY: JOHN LUCAS

nitrogen application. The research has identified optimal nutrient management for wet and dry season vegetable production and targeted site-specific nutrient management strategies. Farmer training activities—'Soil fertility assessment for improved crop nutrient management in vegetable production'—have been conducted with collaborating farmers in Samar, Leyte and Bohol.

### FARMERS TAKE THE LEAD

Work also continues on the protected cropping structures, with Dr Rogers reporting that farmers are now playing pivotal roles evolving their design.

"The cropping structures were vulnerable to extreme wind but farmers devised a way to retract and remove the plastic covering quickly in the event of a typhoon," he says. "This allows farmers to protect their investment in the cropping structures and re-establish the rain shelters quickly at no additional expense. Farmers were also responsible for trialling the use of netting as a way to bypass the need for irrigation under the rain shelters."

As the vegetable initiative progresses, it is building a pool of farmers with extensive experience of protected cropping systems. Dr Rogers reports that these farmers are now providing important extension services, training other farmers and using their farms as demonstration sites. These extension roles receive ongoing support from the farmers' Local Government Unit (LGU).

Among the farmers taking leadership roles is Mr Boie Gerona at Botoc, in Leyte. He maintains four house-style structures and many low tunnels, which he paid for himself. In addition to producing high-value vegetables such as sweet pepper and bitter gourd—without the need for pesticides—he trains other farmers and holds field days. Also spreading the word about the profitability of vegetable farming are Mr Albert Rosillio at Baybay in Leyte and Mr Rafael Payod in Samar.

"In the next phase, we want to help vegetable farmers link more strongly with retailers and supermarkets," Dr Rogers says. "We also want the good agronomic practices used by these farmers recognised through a safe vegetable accreditation system that could earn a premium in the market and open the way to export markets."

He adds that the lead farmers are doing well—and the better they do, the more incentive there is for other farmers to follow suit, with the ACIAR team, the LGUs, and Landcare Philippines committed to providing continuing training and assistance. ■

**ACIAR PROJECT:** HORT2012/020: Integrated crop management to enhance vegetable profitability and food security in the southern Philippines and Australia  
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# EPIDEMIC STRIKES BANANA PLANTATIONS

The Philippines is fighting back against a fungus that can wipe out smallholder incomes from banana plantations

PHOTO: TONY PATTISON



Bananas (variety GCTCV218) growing with a Pinto peanut (*Arachis pinto*) ground cover near Davao in the Philippines as part of a field experiment on the suppression of Fusarium wilt of bananas.

BY GIO BRAIDOTTI

Protecting crops from diseases is paramount to food security, but the problem becomes especially acute for the world's favourite fruit—bananas. A soil-dwelling fungus (called *Fusarium oxysporum* f. sp. *cubense*) has the ability to wipe out entire banana plantations and contaminate the soil for decades, forcing the abandonment of banana farming at affected sites. The fungus is especially destructive as it cannot be controlled by fungicides

or eradicated from the soil using fumigants.

The disease caused by Fusarium fungi is variously called Fusarium wilt or Panama disease. It arises when fungal growth blocks the water-conducting tissue within the stems of banana plants. This essentially starves the plant of water and causes leaves to wilt and the stem to split. Like all living organisms, however, Fusarium can evolve resulting in subsets of races (called 'Race 1' through to 'Race 4') that vary in the varieties of banana they infect.

Major problems arise when a race emerges that infects the variety used to supply international

banana markets. This occurred in the 1950s and 1960s in Central America when a Fusarium race (called Foc Race 1) knocked out the Gros Michel variety. Back then, the crisis was solved by rebuilding plantations and international markets around the now-familiar Cavendish banana variety, which is resistant to Foc Race 1.

The biosecurity threat posed by Fusarium wilt, however, persisted. In 1994, the inevitable occurred: a new strain—Tropical Race 4 (TR4)—was detected in Indonesia that had overcome the genetic resistance of Cavendish banana plants.



Dr Tony Pattison of the Queensland Department of Agriculture and Fisheries (DAF) has first-hand experience of the TR4 crisis. He worked on an ACIAR project in Indonesia that surveyed TR4's prevalence in the late 2000s, at which time the fungus was widespread wherever people were growing bananas.

"Indonesia grows a wide variety of banana types," Dr Pattison explains. "Besides Cavendish bananas, many of the local dessert varieties (that are eaten fresh) proved susceptible, while plantain (or cooking) varieties proved more resistant. In general, the banana varieties that make the most money for farmers proved to be the most susceptible to TR4."

That susceptibility caused a multitude of problems for poor smallholder farmers. Besides the loss of income and of an important staple food, bananas are also important culturally and niche varieties are not easily substituted with

more-resistant cultivars. An example in Indonesia is the highly susceptible Pisang Awak variety that is traditionally brought to wedding ceremonies.

As TR4 spread across South-East Asia, poor rural communities faced similar difficulties. In the Philippines, the government called on ACIAR and the expertise garnered in Indonesia to help defend smallholder banana producers from the devastation that TR4 is capable of wreaking. The project leader is Stewart Lindsay.

#### FIGHTING BACK

In the Davao del Norte province in the southern Philippines, a cooperative of smallholder farmers is reducing the impact of Fusarium wilt on banana yields by adopting disease control practices introduced through an ACIAR project.

Dr Pattison explains that a two-pronged approach was taken: "As a stop-gap measure,

the project introduced Filipino farmers to semi-resistant Cavendish cultivars developed in Taiwan that allow some degree of banana production in the presence of TR4. In contrast, the variety normally grown in the Philippines, Grand Naine, would have succumbed to TR4 within a year."

Concurrently, trials got under way to explore the possibility of suppressing the soil-dwelling TR4 fungi by altering the soil's complement of living organisms and biological activity—the idea of 'suppressive soils'.

Dr Pattison explains that standard operating procedures at banana plantations maintain soils bare and weed free, which amounts to a "biological desert", thereby decreasing the biodiversity of soil-dwelling organisms and allowing TR4 to dominate.

"The project identified that the amount of TR4 inoculum in the soil is responsible for overcoming the resistance of banana plants," Dr Pattison says. "That makes it paramount to keep levels of Fusarium low and, to do that, practices are needed that encourage growth of beneficial soil organisms. We knew from trials in Indonesia and Australia that soil biodiversity can be enhanced by increasing plant diversity on the plantation floor, either as crops or ground covers."

The plant chosen for concurrent trials in the Philippines and Australia is Pinto peanut, a



**"AS A STOP-GAP MEASURE, THE PROJECT INTRODUCED FILIPINO FARMERS TO SEMI-RESISTANT CAVENDISH CULTIVARS DEVELOPED IN TAIWAN THAT ALLOW SOME DEGREE OF BANANA PRODUCTION IN THE PRESENCE OF TR4."**

– Dr Tony Pattison

PHOTO: RICHARD MARKHAM



Tony Pattison discusses options for ground cover plants with a banana plantation manager.

nitrogen-fixing legume, which means the plant also improves soil fertility by increasing nitrogen levels. Pinto peanut is a low-growing plant, well suited to suppressing weeds, with a high level of acceptability by Filipino farmers because it is commonly used in landscaping. There are additional biosecurity benefits to the ground cover as it prevents the transfer of TR4 throughout a plantation via contaminated mud on the soles of workers' shoes.

"Our research partners at the University of the Southeastern Philippines have been screening different ground cover plant species for their ability to suppress TR4," Dr Pattison says. "Interestingly, the

results indicate that the Pinto peanut used in the initial trials provides the best ground cover."

In addition, the Davao campus of the University of Southeastern Philippines is involved in developing tests to measure soil microbial activity, with Australia providing capacity-building training. At the same time, at the Davao Del Norte campus, researchers are helping smallholder farmers to establish their TR4-suppression trial, which they monitor by measuring disease incidence and banana plant health.

"At the farmers' trial site, the resistant cultivars are working well, but the ground cover will require another year to build up the soil biodiversity

before we can assess the suppressive impact on Fusarium wilt," Dr Pattison says.

"Biodiversity is the key to breaking the Fusarium wilt disease cycle because it converts the plantation environment into something more complex and challenging than a monoculture of banana clones in a biological desert." ■

**ACIAR PROJECT:** HORT2012/097: Integrated management of bananas in the Philippines and Australia

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## AUSTRALIAN BENEFITS

Fusarium wilt also affects Australian banana producers. Race 1 has long caused issues for farmers who grow niche varieties such as Lady Fingers, but on 4 March 2015 TR4 was detected in a Cavendish banana plantation in the Tully Valley, Queensland, where it could have caused enormous damage. Instead, the existence of effective diagnostic techniques and biosecurity preparedness meant that Australia uniquely managed to contain TR4 to one farm.

"The experience we gained in the Philippines through the ACIAR projects proved timely for Queensland and the value of that experience has been acknowledged by everyone in the banana industry and the Queensland Government," Dr Pattison says.

Patrick Leahy, who farms a 250-hectare banana plantation next door to the affected site, says the banana industry worldwide was amazed by the TR4 containment achieved in Australia.

"Other countries are looking to us for answers, but they may not be willing to do what is necessary," Mr Leahy says. "Here in Queensland, the Australian Banana Growers Council bought out the contaminated farm and safely cleared it of infected plants while Biosecurity Queensland established an effective quarantine."



Patrick Leahy from Leahy's Bananas in north Queensland, Australia, shares his experiences of banana production and Fusarium wilt with Rita and the production team from the AMSEFCO farm collective in the Philippines.

Also of worldwide interest is the strategy of growing semi-resistant cultivars in soils that are managed to suppress parasites. Mr Leahy is an early adopter, maintaining ground cover between rows of banana plants for the past 15 years and running trials of semi-resistant banana cultivars on his farm even before the TR4 incursion. During that work, he interacted with the same scientists who subsequently worked on the ACIAR project in the Philippines.

Mr Leahy explains that the suppressive-soil strategy was originally developed by Dr Pattison to control parasitic nematodes (which feed on the roots of banana plants). In fact, Dr Pattison discovered that a decline in nematode levels is broadly indicative of a shift to a healthier soil microbiome that is better able to suppress parasites generally. The big hope is that he can get the same degree of suppression of TR4.

"It has been years since I've had to use any nematicides to chemically control nematodes on my farm and my use of herbicides has decreased 50 to 60 per cent," says Mr Leahy, who uses the associated cost savings to help manage risks in years when profit margins are tight.

He adds that while biosecurity threats such as TR4 do occasionally keep him up at night, he prefers to take a proactive approach to protecting his industry. Besides running on-farm trials, he has held industry positions dealing with Fusarium biosecurity threats, including in the Northern Territory, and joined the grower-managed committee advising the ACIAR project in the Philippines, travelling annually to project sites.

"As a grower, I see things differently to scientists and I can talk to Filipino farmers at a different level," Mr Leahy says. "I first travelled to the Philippines in 2013 when I witnessed the total devastation that TR4 can cause. At that time, the Filipino farmers wanted a silver bullet fix. Instead, the project demonstrated that with careful management, banana production is possible with semi-tolerant banana plants despite the widespread presence of TR4."



PHOTO: STEWART LINDSAY

Tony Pattison sampling soil with University of Southeastern Philippines students to measure soil microbial activity at a recently established field trial site near Davao in August 2015.



PHOTO: TONY PATTISON

A banana plant on a commercial plantation in the Philippines showing early symptoms of Fusarium wilt with lower leaf yellowing and leaf death.



PHOTO: TONY PATTISON

Vascular discoloration caused by Fusarium in the pseudostem of a banana plant.



Mangoes being ripened in a Filipino wet market.



Researchers start trials replacing hazardous fruit ripening chemicals with the new, safe RipeStuff™.

PHOTO: KHANHA MOTT

market chains in both developed and developing countries.

"The team has developed a way to cocoon an ethylene molecule in the cavity of a larger carbohydrate molecule, allowing it to trigger fruit ripening without generating explosive levels of gas," Professor Joyce explains. "The new formulation is called Ripestuff™ and it is activated by stirring into water."

During testing in Australia, less than 100 grams of Ripestuff™ was sufficient to ripen 20 tonnes of mangoes in transit from Darwin to markets in Adelaide over three days. The Australian trials, led by Dr Peter Hofman of the Queensland Department of Agriculture and Fisheries, found that Ripestuff™ simplifies post-harvest handling procedures, reducing processing time and costs. Now, Professor Joyce is helping to trial Ripestuff™ in wet markets in the Philippines.

"We want to retain the same practices used in the Philippines for calcium carbide-based ripening, but replace the toxic chemical with the safe Ripestuff™," Professor Joyce says.

He believes Ripestuff™ confers four major advantages. Fruit is ready for market sooner, general fruit quality is improved, handling and treatment costs are lowered, and players in short or long supply chains can supply direct to shoppers ... even if they are smallholder farmers in developing countries.

"The Ripestuff™ formulation is potentially cheap," Professor Joyce says. "The special method for producing the powder is highly efficient, making it cost-effective to use commercially. It can potentially be manufactured under licence in developing countries using a small spray drier. What is important now is to prove the value of it in the field, create the market and get the message out there." ■

**ACIAR PROJECT:** HORT2012/098: Improved post-harvest management of fruit and vegetables in the southern Philippines and Australia

**MORE INFORMATION:** Professor Daryl Joyce, d.joyce@uq.edu.au

## SAFE TO HANDLE

The Philippines stands to benefit from an Australian invention that is vastly improving the way fruit is ripened for market

BY GIO BRAIDOTTI

Easily bruised, fast-to-spoil fruit such as mangoes and bananas require relatively sophisticated post-harvest handling processes to reach consumers in a high-quality, ready-to-eat state. Typically, the fruit is harvested mature green, making it more resilient during transport and storage. Before reaching consumers, the fruit is triggered to undergo ripening.

This involves exposing fruit to a gas that induces the same cellular changes triggered by the natural plant hormone ethylene. In the Philippines, wet market workers use calcium carbide powder to ripen fruit, but the chemical has proven problematic.

Professor Daryl Joyce, a post-harvest horticulture scientist at the University of Queensland and the Queensland Department of Agriculture and Fisheries, explains that while calcium carbide is very convenient for fruit stall owners, the chemical has been banned in many countries, and for good reasons. "Calcium carbide is considered hazardous to the workers who ripen the fruit," he says. "It produces an ethylene analogue, acetylene, which

is unsafe to breathe as it reduces oxygen supply to the brain. Also, industrial preparations are not safe to handle, as they are typically contaminated by phosphorous hydride and arsenic."

Typically, Filipino workers place calcium carbide powder wrapped in newspaper inside baskets of fruit enclosed with newspaper. The calcium carbide reacts with moisture in the air to produce acetylene gas. At high enough concentrations, acetylene mimics the effect of ethylene.

"Alternative ripening methods require using or producing ethylene itself, which is flammable," Professor Joyce says. "Pure ethylene therefore needs to be diluted to below explosive levels with a gas like nitrogen. This is logistically difficult for wet markets in the Philippines, where fruit is typically ripened behind the stall from where it is sold."

Recently at the University of Queensland, Professor Joyce advised a team that developed a new, safe and convenient way to ripen fruit that overcomes problems associated with all existing ripening methods. That work was led by Professor Bhesh Bhandari and involved a PhD student from Vietnam, Binh Ho. Professor Joyce believes that the now-patented invention stands to benefit fruit

PHOTO: DARYL JOYCE

# HORTICULTURE PROJECTS REVEAL DISEASE THREATS, AT HOME AND ABROAD



ACIAR's horticulture projects around the Asia-Pacific region provide advance warning of pests and disease threats before they reach Australia, and occasionally they reveal an existing problem on the home front

BY DR RICHARD MARKHAM,  
ACIAR RESEARCH PROGRAM MANAGER,  
HORTICULTURE

**A**lmost all ACIAR horticulture projects in the Asia-Pacific region, including the current 'crop' of projects in the Philippines, bring some sort of benefit back to Australia's own horticulture sector. Most of the time this arises in a general way, through Australian entomologists and

PHOTO: LEN TESORIERO

Surveying melon fields in Australia.



PHOTO: RICHARD MARKHAM



Biosecurity – team members collect tomato disease samples in the Philippines.

disease that affects Lady Finger bananas, caused by *Fusarium oxysporum* f.sp. *cubense* (Foc) Race 1, as a 'model system'.

As well as providing assistance to the relatively small number of Australian producers of this speciality banana, the researchers would gain useful experience of the use of cover crops and other measures being piloted in the southern Philippines to manage the economically much more damaging Foc Tropical Race 4 that attacks Cavendish bananas. This would stand them in good stead if Tropical Race 4 should arrive in Queensland ... unfortunately, the scourge arrived much sooner than anyone expected. Yet, thanks largely to the experience gained in the Philippines, the Queensland researchers and banana industry were primed to respond quickly and effectively to the invading disease, confining it so far to a single farm (see page 8).

#### UNDERSTANDING THE PROBLEM, REDUCING THE RISK

The projects on integrated crop management (ICM) of vegetables<sup>ii</sup> and mango<sup>iii</sup> provide several examples of the 'advance warning' type of benefit. In working out how to manage an unfamiliar disease in the Philippines, the Australian and Filipino researchers have been asking a range

of key questions. What crops and varieties are affected? How much damage does it cause? What is its seasonal incidence? How does it spread—is it carried by insects (and, if so, which ones?); is it carried through the seeds of the crop; does it survive in the soil, in dead plant material, in other weeds or wild plants? The answers to these questions will help researchers and farmers figure out an 'integrated' approach to managing the pest or disease—ideally with little or no recourse to pesticides.

The answers to these questions also help Australian biosecurity specialists to assess the risk posed by the presence of these pests and diseases on farms in neighbouring countries and in commodities and seeds imported to Australia. Armed with this knowledge, policymakers and inspectors can focus their attention on the 'pathways' that pose the greatest risk (such as commercial imports of fresh fruit from a specific country or region) or modify their surveillance to concentrate on the plant species and plant parts or products that are most likely to carry a specific pest or disease (for instance, when checking passenger baggage at airports). Australia, as an island, has a built-in advantage in addressing biosecurity risks, but making the best use of this advantage depends on knowing 'what's out there.' →

plant pathologists working with their counterparts in the Philippines and elsewhere, getting to know and understand the potential threats to horticulture long before they arrive in Australia. Sometimes the benefit to Australia is a planned objective of the work, as in the current project on Panama disease of bananas in the Philippines. Just occasionally, a large and unexpected benefit arises serendipitously from the routine work.

The banana project design<sup>i</sup> called for work in Queensland to focus on the version of Panama



Paula Ibell at Walkamin with a small tree tagged for modelling study.

PHOTO: RICHARD MARKHAM

## FORTUNE FAVOURS THE MELON

In the vegetable ICM project, Dr Len Tesoriero, a plant pathologist from the NSW Department of Primary Industries, also focuses on *Fusarium* wilt diseases, but in his case the focus is on pathogens of solanaceous crops (such as tomatoes and peppers) and cucurbits (such as cucumbers, melons and bitter gourd—or ampalaya, as it is known in the Philippines). As well as isolating and characterising these pathogens from crops in the Philippines, the team carried out surveys in Australia, confirming *Fusarium oxysporum* f. sp. *melonis* as the pathogen responsible for disease in rockmelons in NSW. On the other hand, surveys of Asian melons across the major production regions in Australia found no sign of vascular wilt disease.

In the course of their surveys, however, the project team detected something quite unexpected—and potentially destructive to the Australian melon industry: *Cucumber green mottle mosaic virus*. The disease had never been detected in Australia before and the nearest known occurrence of the disease was far away, in the northern hemisphere. The discovery, on a farm in the Northern Territory of Australia, caused consternation and affected melon crops had to be destroyed. Though hard on the growers concerned, this resolute action was necessary to prevent the spread of the disease—and much greater losses—across the industry.

The researchers came to the conclusion that this seed-borne virus must have come into Australia with supplies of seed from overseas, which had not been tested for this pathogen. Its discovery led to a change in procedures, protecting against this risk to Australian horticulture in the future. Perhaps equally important to the future of this industry in Australia, the melon growers have subsequently agreed to an R&D levy to support future research. This in turn has enabled Horticulture Innovation Australia to support a project to better understand the threat of this potentially highly destructive disease.

It may seem like a long way from the tiny ampalaya plots of the southern Philippines to the broad melon fields of Australia. However, the networks of researchers and exchanges of knowledge supported by ACIAR projects serve to bring benefits to people at both ends of this axis. ■

**ACIAR PROJECTS:** i HORT/2012/097 Integrated management of *Fusarium* wilt of bananas in the Philippines and Australia

ii HORT/2012/020 Integrated crop management to enhance vegetable profitability and food security in the southern Philippines and Australia

iii HORT/2012/019 Integrated crop management to enhance mango production in the southern Philippines

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## SMALLER TREES, BIGGER REWARDS

Mangoes are the national fruit of the Philippines and Filipinos consider the local Carabao variety to be the best mango in the world. Yet most mango trees in the Philippines are well past their prime and mostly left to grow with a minimum of management.

“Our first challenge is to persuade growers that if you prune these old mango trees to reduce their size and open up the canopy, they will give you a whole lot more fruit,” explains Dr Ian Newton, leader of ACIAR’s mango integrated crop management project in the southern Philippines. As he explains it, there are multiple benefits from what the experts call ‘canopy management’: the first and most important is simply to let in more light. This stimulates the mango tree to produce fresh shoots, which then flower and produce more fruit.

If farmers are prepared to try the idea that ‘less can be more’, then it is also easier to apply plant protection measures, such as fungicide and insecticide sprays, improving their effectiveness and reducing wastage. When trees are pruned to a reasonable size, it is also easier to ‘bag’ the fruits to protect them from insect pests and to harvest the fruits without bruising them.

Dr Ana Notarte of the agricultural department of Davao del Norte has been helping growers on Samal Island get organised to export mangoes and offering them hands-on training. “We are giving the small-scale growers season-long training in best-bet practices,” she says. “Once they have seen how these practices improve their returns, they no longer hand their trees over to contractors to look after. They take care of the trees themselves—and reap the benefits.”

In Australia, Queensland’s mango growers have for some time been managing medium-sized trees at medium densities as standard practice in their orchards. Now researchers from Queensland’s Department of Agriculture and

Fisheries are pushing forward to try ‘small trees’ at high density. In a trial at Walkamin Research Station, funded by Horticulture Innovation Australia, researchers are testing different planting densities and management regimes to obtain the greatest possible productivity.

Dr Paula Ibell, who also works with Dr Newton on the ACIAR southern Philippines project, points to a series of trees festooned with coloured tags. “Every twig and branch on these trees is measured to provide data on tree architecture. Analysing these data helps us understand how the management regime affects the vegetative growth, flowering and fruiting,” she explains. Early results from the high density plantings are very promising, with the researchers recording yields from three-year-old trees up to five times higher than in conventional orchards.

As part of the Walkamin trial, the ACIAR project is contributing to the evaluation of a further innovation: growing mangoes on trellises. Trellising has revolutionised the production of some temperate fruits, such as cherries and apples, and now is being tried for the first time on tropical species such as jackfruit, rambutan and cocoa, as well as mango. As Dr Ibell says: “It is still early days for these trials but we are learning how various mango varieties respond to different trellising methods.”

The goal of the research team is to increase yields to as much as 50 tonnes per hectare using high-density trellis technologies. Dr Ian Bally, Queensland’s mango breeder, reckons: “Such productivity gains will underpin exports and transform the reliability and profitability of the Australian mango industry.”

As an added bonus, the trellised trees and high density plantings have withstood the ravages of recent cyclones much better than traditional orchards. Researchers and growers alike will be monitoring the results of the trials closely.

# TO THE RESCUE OF SANDFISH

The development of commercial-scale hatchery and grow-out technologies are helping to restore livelihoods dependent on sandfish

BY ANDREW COOKE

Part of a long-term strategy: Filipino sea cucumber farmers with some of their produce.

PHOTOS: PAUL SOUTHGATE

They have a multitude of uses and names—beche de mer, sea cucumbers, sandfish, *Holothuria scabra*—but for coastal communities in the Philippines these odd-looking creatures are primarily an important source of income.

After years of overharvesting, however, the wild resource—a prized commodity consumed as food or medicine in China and other parts of Asia—was becoming severely depleted. Through ACIAR, researchers identified a range of potential benefits from restoring coastal livelihoods and ecological function by developing commercial-scale hatchery and grow-out technologies for sandfish.

“It’s about advancing the methodology for sea cucumber culture,” the project leader, Professor Paul Southgate, says. “This is based around the fact that the target species has very high demand when processed in South-East Asian countries, and can fetch up to A\$400 a kilo. As a result, in a lot of areas, these animals are now overfished. Aquaculture is seen as a means of tapping into that demand and providing local livelihoods in the countries where sea cucumbers are fished. The project really addresses the

question: how do we do that? How do we farm sandfish at a large scale?”

The project—which has seen hatchery output significantly increase despite the devastation wreaked by Typhoon Haiyan in November 2013—has nodes in the Philippines, Vietnam and Australia’s Northern Territory.

One of its main focuses has been on streamlining hatchery processes. “We’ve made very big advances in large-scale hatchery production,” Professor Southgate says. “We have developed methodology to use commercial micro-algae concentrates as a food source for the larvae. So instead of culturing live micro-algae—which requires a lot of infrastructure and expertise and is costly—we now buy the food source in a bottle. It is produced commercially in the US and we buy it in as needed. This simplification to the hatchery process has resulted in more effective hatchery production.”

While there have been significant challenges, community engagement across the Philippines and Vietnam has been strong, Professor Southgate says.

“As much as I would like to think that we can look at meaningful scale-up of these field-



based activities over the short term, the reality is that it is not just about the science—it’s about social engagement, it’s about cultural issues and governance. So all of these steps have to be considered and they are all part of the long-term strategy towards developing this industry.”

There will be a five-year, \$2.4 million follow-on project to the current research, starting in January 2018. The project involves the same partners across the Philippines, Vietnam and the Northern Territory and its goal will be to address technical bottlenecks identified in the initial project. ■

**ACIAR PROJECT:** FIS/2010/042, Expansion and diversification of production and management systems for sea cucumbers in the Philippines, Vietnam and northern Australia

**MORE INFORMATION:** Professor Paul Southgate, University of the Sunshine Coast, psouthgate@usc.edu.au

# DEVELOPMENT DEFINED BY POOR FARMERS

Farmers provided with the right kind of support are using market-oriented agribusiness models to create new income-earning opportunities

BY GIO BRAIDOTTI

**F**or extremely poor farmers, ensuring there is enough food to feed the family year-round is the foremost consideration. Changes in farming practices that potentially place that fundamental lifeline at risk face enormous psychological barriers, even if they are associated with long-term benefits. When new opportunities abound, however, Filipino farmers are proving they will risk transformational change to establish profitable market-oriented agribusinesses, but only if the right kind of support


is provided. Learning how to deliver that support to farming communities has been a prime objective at ACIAR, as demonstrated by an ACIAR project that is working with smallholder vegetable and mango producers. The project is active across four sites in the southern Philippines where poverty levels average 35 to 45%.

A key project finding is that when poor smallholder farmers act as individuals, they often lack the capacity to run a business linked to modern market chains; they can, however, overcome these deficits by acting collectively. Like the farmers, the Australian team members from the

University of Queensland who lead the project are taking a collective approach. Three academics share leadership, thereby allowing the project to draw on expertise normally segregated in different academic disciplines. Dr Phillip Currey provides expertise in agribusiness. Dr Gomathy Palaniappan provides the project with community development capacity. Finally, Dr Oleg Nicetic provides the agronomic expertise to solve production challenges.

In addition, the project links with the University of the Philippines, Mindanao, Visayas State University, a Landcare Group and other ACIAR teams in the Philippines, with the research network sharing

PHOTO: OLEG NICETIC



Tunnel structures help vegetable farmers in Cabintan, Leyte, avoid waterlogging and disease issues associated with the area's high rainfall.



expertise and project findings across agronomy, post-harvest handling, marketing and safe vegetable production practices and accreditation.

“At each site, the project is about far more than changing agronomic practices,” Dr Currey says. “It is about changing the whole culture of how farmers work together, how they sell, plan, schedule. But a one-size-fits-all strategy will not work. You have to engage with each community and provide long-term support to build trust, capacity, communication channels and the empowerment needed to drive innovation.”

### MARKET-ORIENTED PRODUCTION

Across the project sites, the ACIAR team discovered that farmers were often ‘selling all-in’, meaning that ungraded harvest (containing everything from premium to processing grade mixed together) was being sold in bulk to collectors who profit from selling graded produce. As a result of selling all-in, farmers were paid low average prices.

Dr Nicetic explains that grading adds value and whoever does it captures the extra income. “Selling all-in versus selling by grade makes a big difference to farmers’ income.”

To help farming groups shift to selling directly

by grade, the ACIAR team offered a service that farmers were unlikely to have asked for themselves—market research.

Dr Currey explains that the team opted to map the entire market structure and value chains available to the farmers, identifying a spider’s web of distribution channels and market segments for vegetables and mangoes, along with impacts from the emergence of convenience shopping in supermarkets.

“Our approach was unusual,” Dr Currey says. “Rather than focus on a few high-value chains, our research was designed to match the farmer’s production capability with the most appropriate market segments—the ones the farmer could best satisfy. We then built in the ability for continuous improvement so the farmers can gain access to further segments, including buyers in more valuable segments.”

This process was especially prominent on Samal Island, where about 3000 farmers produce a unique mango variety all year round. While the producers sell all-in, the mangoes are classified and sold in grades spanning from a premium grade exported to Japan and Korea through to processing and local wet market grades. The →

### AT A GLANCE

**This ACIAR project is transforming income-earning opportunities for poor farmers. A multi-disciplinary approach makes transformative changes to farming practices possible.**

**Agronomic innovation is delivered within a greater package of community and agribusiness development.**

**Participating farming groups are not only growing high-value crops; they also have new skills in post-harvest handling, grading, marketing, and safe vegetable production practices and accreditation.**

PHOTO: OLEG NICETIC

A bumper crop of tomatoes is harvested from within a protected cropping structure in Cabintan, Leyte.



Farmers in Cabintan, Leyte, vote to introduce capsicum as a new crop for cultivation within the farming group's protected cropping structures.

**"BUYERS NOW ACCEPT THAT FARMERS ARE ABLE TO GRADE AND HANDLE THE PRODUCE, WITH EVERY GRADE FETCHING A DIFFERENT PRICE. THE FARMERS ARE MOTIVATED TO INCREASE PRODUCTION OF THE MOST PROFITABLE GRADES, WHICH RESULTS IN A GAIN IN QUALITY."**

– Dr Oleg Nicetic



PHOTO: OLEG NICETIC

market research allowed the farmers to make contact with buyers from each of those grade classifications for the first time.

"We discovered that buyers were frustrated because they could not source mango of the standard and quantity they needed, when they needed it," Dr Currey says.

In 2017, the team ran a workshop to create effective communication channels among buyers, technical advisers and farmers to help ensure that market needs are aligned with technical solutions. In addition, a small group of leading farmers are facilitating adoption of the new practices by communicating and demonstrating the benefits to other farmers, with the ACIAR team on hand to provide support.

"Ultimately this will allow farmers to sell a bigger percentage of their fruit for the premium prices," Dr Currey says. "When our time is up, the technical skills in the country will be available to the farmers on an ongoing basis. The structures we put into place were about empowering this farming group to drive the change."

In a similar vein, at a peri-urban project site in the upland boundaries of Davao City, vegetable farmers have forged links with Gaisano Supermarkets. In Cabintan, a remotely located ward of Ormoc City in the typhoon-prone province of Leyte, supermarkets on nearby Cebu Island and Tacloban City were the most attractive market for small-scale vegetable producers. In Cagayan de Oro in the conflict-affected province of Misamis Oriental, vegetable producers created their own value chains, acquiring market stalls and selling directly within government offices.

"Buyers now accept that farmers are able to grade and handle the produce, with every grade fetching

a different price," Dr Nicetic says. "The farmers are motivated to increase production of the most profitable grades, which results in a gain in quality.

"That kind of change has proven difficult to make in the past, but we now have a model that is working. As to the labour involved, it is possible because the farmers are working collectively. They can organise work teams to do the harvesting, washing, grading and packing, all without fancy equipment. They are very well organised and there is very little wastage from the field to the supermarket.

#### FARMER-DRIVEN INNOVATION

Another key leverage point for project activities was the discovery that many farming communities have been excluded from decision-making processes. The classic example is the loss of choice in what crops to grow that is inadvertently caused by the provision of free seed by the Department of Agriculture. Dr Nicetic says that when combined with all-in selling, there is not much income available to farmers who use traditional practices.

Dr Palaniappan and her team undertook baseline surveys to understand the challenges and aspirations of communities at each project site. She says that the key to mobilising farming groups and helping them act cohesively is to articulate a vision of what development means to the community.

"That vision is what brings the group together, gets members active in planning farming activities, in organising labour and agreeing on income distribution," she says. "Interpersonal dynamics within any group make leadership crucial and it is important to address gender roles so that women also benefit, with flow-on benefits to families. These issues were addressed through a series of

activities, meetings, discussions and workshops."

The need for this kind of cohesion became crucial in the wake of Typhoon Haiyan at the Cabintan site. The village sits 800 metres above sea level, which potentially allows for year-round vegetable production without the challenge of extreme heat or flooding. It is an area where the Philippines Energy Development Corporation (EDC) is active, partnering with farming communities to promote development and reforestation as part of EDC's corporate social responsibility program. In the aftermath of Typhoon Haiyan, the area experienced a chaotic influx of aid and aid organisations. Despite this support, farmers struggled to benefit from the assistance.

This changed when the ACIAR team formed a Technical Advisory Committee (TAC) chaired by an ACIAR project partner, the Visayas State University, to better coordinate between community needs and the assistance made available by ACIAR, local government, the local chamber of commerce, the Department of Agriculture, the EDC, and aid from Israel, which subsequently provided capital for infrastructure work, including irrigation systems and about 30 greenhouses.

Market research helped farmers identify supermarkets on nearby Cebu Island and Tacloban City in Leyte as the most attractive and they changed production practices in order to meet the demands of their target market. "The TAC organised a production schedule of the right crops at the right time," Dr Nicetic says. "All this post-typhoon activity amounted to transformational change in what they produce, how they market, and even how they are paid."

Eventually, when Visayas State University invited

30 to 40 buyers from supermarkets in Cebu to visit the project site, they were “blown away” by what they saw, says Dr Currey. “The relative sophistication of the on-farm production, handling and grading system for tomatoes and capsicum surprised them and they placed orders straightaway, which is unheard of in this kind of environment.”

Dr Nicetic adds that the impact on farmers was profound: “It is really important to understand that when income increases a lot for farmers, they may need support initially to help manage that money. The extra income can increase community development or create inequalities that can cause communities to fall apart. That’s another reason for having the community development component of the project. It is actively assisting the community make decisions about the distribution of money and reinvestment.”

Dr Palaniappan, who led the community development work, says that the Cabintan farmer organisation has now grown to a level where it has the ability to maintain preferred market linkages and even forge new ones. “Leadership by the farmers is moving towards a state where they can sustain their own development.”

### THE RIGHT PARTNER

At no point during the project did the Australian researchers work alone. For example, at Cagayan de Oro, the team initially envisioned large-scale tomato production in this upland area. They changed this objective when they were approached by the local mayor to work on peri-urban vegetable production on the outskirts of the city.

A Technical Working Group was established with City Agriculture agronomists, the Northern

Mindanao Vegetable Marketing Cooperative and Landcare Philippines, which has a lot of expertise with farming community development.

“As farmers gain confidence and the skills to link with various institutions, they are able to mobilise resources for the benefit of their community,” Dr Palaniappan says. “For example, the farmer associations were able to contact the City Agriculture office to access equipment, such as tractors and shredders, and inputs such as seed and water pumps. The Local Government Unit of Pagatpat offered a space to sell their vegetables to the local consumers close to the Barangay Hall.”

At the other peri-urban site within the boundaries of Davao City, farmers initially lacked the capital to make the production changes required by Gaisano supermarkets. That changed when the project introduced farmers to a microfinance NGO, the Centre for Community Transformation (CCT).

Dr Palaniappan says that in addition to providing capital, CCT engages in community development. “They promote a philosophy that encourages people to think about the principles of honesty, liability, commitment, happiness and the ability to work together,” she says.

“CCT also introduces saving habits and financial planning skills. This is crucial to the success of farmers who normally work on a cash-in-hand basis. For example, farmers managed bank passbooks for the first time, tracking their income as individuals and as a collective. They even acquired familiarity with the Bureau of Internal Revenue’s procedures and paperwork.”

Change this profound has never been seen before using traditional extension services. The ACIAR

team stresses that season-long engagement—from the time they prepare land, all the way through to postharvest handling and marketing—is absolutely necessary to foster change.

“At the Davao City site we have now completed three cycles with the farmers to really facilitate the transformation from their traditional subsistence farming,” Dr Nicetic says. “At every site we had long-term engagement along with support from Filipino research partners and third-party organisations such as CCT.”

All the farming communities that participated in this project are now being offered the opportunity to participate in a new ACIAR project that will add further value by helping farmers to acquire accreditation to market ‘safe vegetables’ under the banner of the Philippines Good Agricultural Practices (GAP) certification. This involves minimal use of pesticides when producing vegetables and no pesticide residues on marketed produce.

“Once again, the approach involves empowering and equipping farmers to make informed decisions about what they produce and to challenge traditional production methods in order to enhance their wellbeing and income,” Dr Nicetic says. ■

**ACIAR PROJECT:** AGB/2012/109: Developing vegetable and fruit value chains and integrating them with community development in the southern Philippines

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**“AS FARMERS GAIN CONFIDENCE AND THE SKILLS TO LINK WITH VARIOUS INSTITUTIONS, THEY ARE ABLE TO MOBILISE RESOURCES FOR THE BENEFIT OF THEIR COMMUNITY.”**

– Dr Gomathy Palaniappan

ACIAR assistance to poor farming communities in Cabintan, Leyte, extends from improved agronomic practices for growing high-value vegetables through to postharvest handling and marketing.

# TO THE AID OF CORAL REEF HABITATS

Techniques to restore the coral foundation of damaged reef habitats have been successfully trialed in the Philippines



New adult corals populate a damaged reef site as a result of the ACIAR coral restoration project.

BY GIO BRAIDOTTI

**A**s alarm bells ring worldwide over damage to the planet's coral reef habitats, an ACIAR team working in the Philippines has achieved the first mass reseedling of coral colonies to help restore damaged reefs.

The project developed techniques to raise coral larvae either in aquaculture facilities or directly in the sea, with the successful restoration trials arousing interest among reef management

agencies around the world, including Australia.

The ACIAR project is led by Professor Peter Harrison, the director of the Marine Ecology Centre at Southern Cross University in northern NSW. Professor Harrison made seminal discoveries about the reproductive biology of corals during PhD studies on the Great Barrier Reef in the 1980s. Now, Professor Harrison says the reasons to attempt coral restoration efforts are overwhelming.

"Corals are everything to a reef—they are foundation species that provide the reef's three-

dimensional structure," he says. "Those structures then serve as nurseries for fish and habitats for hundreds of thousands of reef organisms that simply disappear if the coral colonies are killed."

Corals are faring badly worldwide, but the problem is especially acute in South-East Asia where about half of all coral reefs have been destroyed. Besides pollution and an increase in environmental stresses (such as rising ocean temperatures), these reefs are also being damaged by blast fishing. This involves detonating cheap explosives over coral reefs to stun or kill fish, which



Dexter dela Cruz and Peter Harrison adding coral (*A. tenuis*) larvae into a resealable portal of the mesh enclosure to seed restoration of corals on a damaged reef in the Philippines.

PHOTO: KERRY CAMERON



PHOTO: PETER HARRISON

Mesh curtain deployed on a coral reef restoration site.

undergo sexual reproduction.

In the 1980s, Professor Harrison was involved in the discovery of something unusual about coral sexual biology. To maximise opportunities for novel genetic recombinations, many corals spawn en masse, releasing vast quantities of egg and sperm bundles that form slicks on the surface of calm waters.

Once fertilised, the eggs grow into millimetre-long, maggot-like larvae over several days. If the larvae can find a suitable spot to settle on the reef, they metamorphose into juvenile polyps, grow tentacles and start feeding. After six weeks, the polyps are big enough to start dividing and the colony-producing process gets under way.

"Colonies can be many decades old and grow into areas that are over 10 metres wide," Professor Harrison says. "But they all start as tiny larvae, with only a minuscule percentage surviving to form large coral structures."

#### HOW TO FOSTER BABY CORAL

The Philippines lies within the Coral Triangle that includes 35% of the world's coral reefs and more than 75% of all coral species—a degree of biodiversity greater than the Great Barrier Reef. The Philippines' reefs are worth more than US\$2 billion annually from fishing, tourism and the storm protection services they provide. Despite their environmental, social and economic value, about 98% of the Philippines' reefs are classified as threatened.

ACIAR's reef restoration work is being undertaken in the reefs of northern Luzon. The method involves raising millions of coral larvae and then assisting their settlement into damaged areas using underwater enclosures or tents made of fine mesh. To obtain coral larvae, two techniques have been developed.

The first involves temporarily relocating mature coral colonies to a laboratory tank with flow-through seawater at the aquaculture facility of the Bolinao Marine Laboratory. The controlled environment makes it possible to experimentally maximise fertilisation rates (currently at close to 100% efficiency) and larval survival rates.

The team is also developing protocols for the wild capture of egg-sperm bundles during mass spawning events. The capture involves using protective mesh enclosures on the reef's surface before larvae are transferred to the underwater tents for five to seven days for settlement. The mesh tents are then removed and the settlement site monitored.

"To scale up this kind of restoration work for larger reef areas, it will be essential to have reliable methods to rear larvae at sea," Professor Harrison says. "Our first successful spawn capture took place in 2016 and each time we do it we refine our ability to do the rearing work at sea." →

are then scooped up as they float to the surface.

Professor Harrison considers the practice a sign of poverty and desperation, an easy way to harvest the last of dwindling fish stocks to feed impoverished families.

The blasts, however, are so damaging that they convert complex underwater coral forests into rubble. Paradoxically, in the search for alternative and more profitable income streams, coral reefs and their conservation and restoration stand to play pivotal roles in the Philippines and around the world.

#### CORAL BIOLOGY

Corals are unusual organisms. They are animals, yet they host photosynthesising, single-cell algae and they also secrete a calcium carbonate exoskeleton, which is responsible for the rock-like appearance of corals.

The animal part of a coral colony is made up of genetically identical polyps that can reproduce asexually by simply splitting into two. Polyps, however, can generate new genetic identities—the grist for the mill of adaptation and evolution—by releasing eggs and sperm bundles that

### RESTORATION GETS UNDER WAY

In April 2016, colonies of *Acropora tenuis* branching coral derived from artificially reared larvae became sexually active and spawned for the first time, just three years after the ACIAR team's first coral restoration attempt. A second trial with a slower-growing branching coral species is due to spawn in 2017.

The successful restoration trials have since spawned a larger ACIAR project that so far has raised 4.5 million larvae, resulting in about 250 new baby corals that in mid-2017 were the size of 20-cent pieces, with their growth rate due to accelerate.

"With the new project, the aim is to get as many new coral colonies on the reef as possible," Professor Harrison says. "By using sexually produced larvae for the restoration, we bring into the new colonies the extra genetic diversity needed to ensure survival of the fittest larvae and the best-adapted genotypes."

### COMMUNITY ENGAGEMENT

As coral restoration efforts gain pace, new habitats for many other species are being created, including the fish that local communities rely on for food and income. The success of ongoing restoration work, however, hinges critically on the Filipino technical partners at the University of the Philippines—who will eventually take over the reseeded work—and the engagement of local communities who rely on or visit the reefs.

To aid with capacity-building, the ACIAR team works closely with its in-country technical partners. They also provide numerous opportunities for Filipino students to undertake postgraduate

research work on the coral project. Among them is Mr Dexter dela Cruz, who has proven integral to the project's success.

The team also works closely with local communities and municipal authorities to foster mutually beneficial stewardship roles for ongoing preservation and restoration efforts.

Helping to build community engagement is Professor Jeffrey Bennett, an environmental economist at the Australian National University. His socio-economic surveys have created an understanding of the reef's value to local communities and the experience of visitors to the region, even comparing responses to the restored and damaged reefs. This information has informed the development of training workshops and education materials for communities, visitors and local schools that explain the importance of corals to both the health of the environment and of people.

"Where we work, the municipal mayor was elected on a platform of stopping blast fishing," Professor Harrison says. "As a consequence, detonations are becoming rare occurrences. These days, local communities respond to the sound of blasting by jumping in their boats and chasing away the blast fishers from the reef, so the reefs have a chance to recover."

### AUSTRALIAN BENEFITS

Among the many reefs around the world that stand to benefit from coral restoration technology is Australia's Great Barrier Reef. Prior to recent mass bleaching events (which are due to more frequent spells of abnormally high seawater temperatures), the Great Barrier Reef had already lost half of its

corals in the previous 30 years. Public concern is running high over the reef's health.

With word spreading about the success of restoration efforts in the Philippines, new policies may be developed to support reef restoration in other reef regions, including the World Heritage-listed Great Barrier Reef.

Given that the Great Barrier Reef is worth about \$6 billion to the Australian economy each year, the combination of conservation and restoration work has important cultural, ecological and economic implications. In addition, technical manuals are under development to help guide restoration efforts worldwide and scientific papers are being published based on the data produced at the Philippines restoration sites.

"Once we know how best to scale-up the rearing of millions of larvae at sea, we want to test the feasibility of selecting for heat tolerance within the reseeded population so that restored coral colonies can better withstand bleaching events," Professor Harrison adds.

"The potential even exists to accelerate the adaption process to warmer ocean temperatures that reefs are experiencing through selective breeding for heat tolerance of the coral polyps, of the photosynthesising single-cell algae, or both. As such, restored coral is a source of genetic diversity that could help us future-proof reef systems against climate change." ■

**ACIAR PROJECT:** FIS/2014/063: Restoring damaged coral reefs using mass coral larval reseeded

**MORE INFORMATION:** Peter Harrison, peter.harrison@scu.edu.au

PHOTO: PETER HARRISON

A larval mesh enclosure attached to a reef at a coral restoration site in the Philippines.

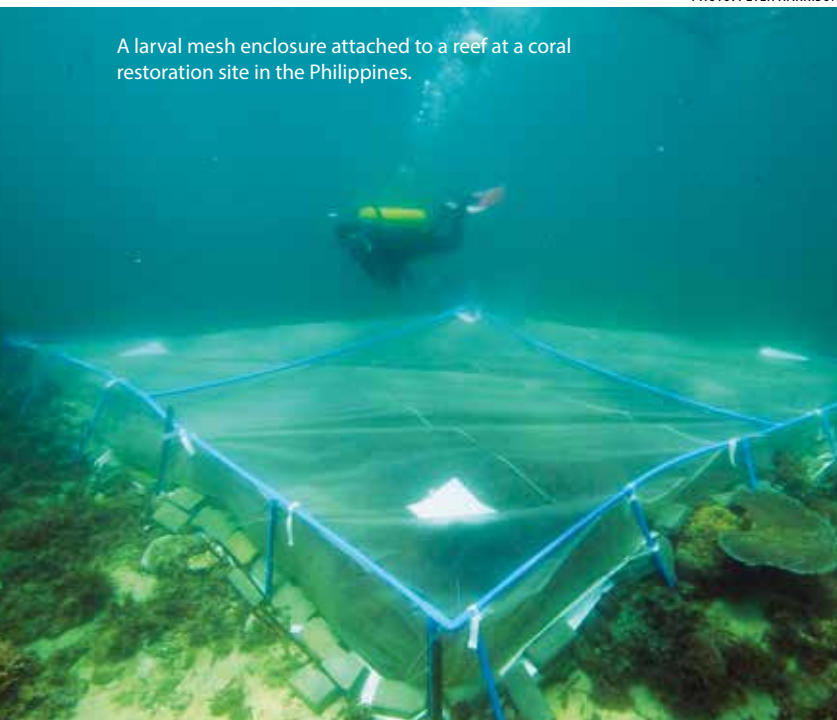


PHOTO: PETER HARRISON

A newly designed mass coral larval rearing enclosure ready for deployment.





## THE LIVELIHOOD VALUE OF SEAWEED

Income earned from cultivating seaweed provides vitally important income for many poor coastal villages

BY ANDREW COOKE

Whether we are aware of it or not, most of us eat seaweed every day, says marine ecologist Associate Professor Symon Dworjanyn. Products such as ice-cream, flavoured milk and toothpaste frequently contain the seaweed extracts agar and carrageenan, which are used for their thickening and stabilising properties.

The seaweed aquaculture industry in the Philippines and Indonesia is worth about A\$200 million. For many coastal communities, seaweed is the only source of income, which means productivity levels have important livelihood impacts. Seaweed aquaculture is a top foreign exchange earner for the Philippines, with 80% of exports based on *Kappaphycus* strains of seaweed.

In recent years, though, the industry has suffered steady declines in productivity, Associate Professor Dworjanyn says, primarily because of its reliance on a handful of cloned strains. In 2010, an ACIAR project was established to arrest these declines, with the project concluded in December 2016.

"One of the issues with seaweed farming is the

disease ice-ice, which reduces productivity and collapses production," he says. "With the project, we were trying to find strains of seaweed that are resistant to ice-ice, but in the process discoveries were made that relate to growth rates. We think there is an opening for the industry to grow a particular reproductive phase of the seaweed and get higher productivity."

The project researchers also achieved significant success developing a technique for growing seaweed in the ocean, rather than ponds.

"After speaking to the industry and some of the farmers in Sulawesi, Indonesia, we came up with a way to grow *Gracilaria* (a red seaweed) in the ocean," Associate Professor Dworjanyn says. "We encouraged one farmer to try mariculture of *Gracilaria* and it was amazingly successful."

Upon witnessing this success, farmers in the whole village changed to *Gracilaria* ocean farming, and the practice is now spreading throughout eastern Indonesia. It also means that people who were growing *Kappaphycus* now have another species they can cultivate that is more profitable: "Just in that village alone, they are now producing about A\$2 million a year of this seaweed, and we

have about 1000 families living off the proceeds," Associate Professor Dworjanyn says.

As well as helping South-East Asian producers and communities, the project was beneficial to the Australian team members. For example, they are now using newly acquired expertise with seaweed farming for studies into growing pharmaceutical-grade agar in Australia.

The project also had an unexpected, but beneficial impact. When Typhoon Haiyan went through the south-central Ilo Ilo area of the Philippines in 2013, seaweed farmers lost all of their gear and seaweed stock: "We were able to go out and restart seaweed farming with many of the regional farmers," Associate Professor Dworjanyn says. "We lost all of our experiments, but we had nurseries and resources on land that were intact, so we could resupply them with seaweed farming seed, so they could start up again." ■

**ACIAR PROJECT:** SMAR/2008/025, Improved seaweed culture and postharvest waste utilisation in South-East Asia

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# GIANT CLAMS AND UNEXPECTED IMPACTS

*Tridacna gigas* in the lagoon near Bolinao Marine Laboratory—this species was all but extinct in the Philippines before the project began.

PHOTO: ANNE MOORHEAD

One of ACIAR's earliest projects, on aquaculture of giant clams, is demonstrating impacts beyond anything anticipated when it was set up in the 1980s

BY ANNE MOORHEAD

Professor Edgardo Gomez may not have single-handedly saved the 'true giant clam', *Tridacna gigas*, from extinction in the Philippines, but it certainly would not have happened without him. Returning from studies in the United States in the 1980s, he played a key role in one of ACIAR's first projects, 'The culture of the giant clam (*Tridacna* spp.) for food and restocking of reefs,' as Philippines project leader.

Today, there are estimated to be tens of thousands of giant clams on the reefs around the islands of the Philippines—an unmitigated success in terms of the project's restocking objective. However, the giant clams are not there for food. Instead, and unforeseen by the original project planners, they are an increasingly valuable asset to a booming tourism sector, as well as a boost to reef health for fishing communities. "Things happened that we couldn't have predicted at the start of the project," explains Professor Gomez, who is in his 70s

but no less committed to giant clams than he was 30 years ago. "We had to take a change of direction in 1996, when the Philippines government suddenly banned all giant clam exports."

The early giant clam projects, which were also set up in Fiji, Kiribati, Papua New Guinea, Solomon Islands and Tonga, were a response to the drastic decline in giant clam populations across the Pacific caused by local overharvesting as well as poaching by foreign vessels. Research groups across the region joined forces to come up with the solution—an aquaculture system that linked giant clam breeding at national hatcheries with community farming of juvenile clams on the reefs, and ultimately with commercial markets that would provide economic sustainability and incentive.

## ADVANCING GIANT CLAM SCIENCE

In the late 1980s and early 1990s, the projects were a great success in terms of scientific and technical advances. A series of ACIAR publications from 1992 chart the progress—*The giant clam: an*

*anatomical and histological atlas; The giant clam: a hatchery and nursery culture manual; The giant clam: an ocean culture manual; and Giant clams in the sustainable development of the South Pacific.* But economic success proved more elusive. The story is slightly different in each project country, but in the Philippines the government decision in 1996 was a major setback to accessing the lucrative international aquarium trade.

"We had been focusing on *Tridacna derasa* up till then, as they were the most suitable for that market," says Professor Gomez. "But at that point we decided to switch to *gigas* and to restocking the reefs around the country with this almost-extinct species." While the export ban may have been viewed as a setback at the time, today he sees it in quite a different light.

Then there was another lucky break for the project in the early 2000s when Professor Gomez was awarded a fellowship by the Pew Foundation, and with it a generous grant that he immediately deployed to assist the aquaculture and restocking





Performing maintenance and cleaning of the juvenile giant clams in the lagoon nursery, close to Bolinao Marine Laboratory.

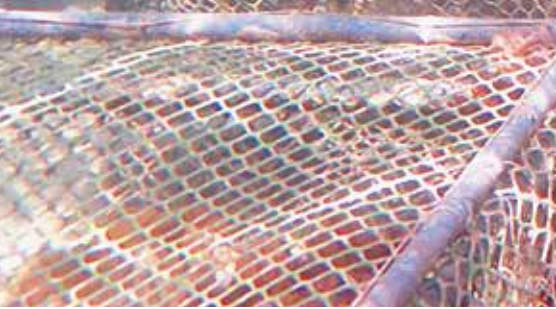


PHOTO: ANNE MOORHEAD

program. By 2006 he was able to publish impressive numbers in an article 'Achievements and lessons learned in restocking giant clams in the Philippines'—more than 70,000 giant clams restored to the reefs around the country by the aquaculture program.

Today, both the restocking program and giant clam-related research continue at the University of the Philippines' Bolinao Marine Laboratory. Young giant clams continue to be in high demand across the country, and the laboratory runs regular training courses so that community members and resort staff know how to care for the juveniles when they receive them from the hatchery. As well as being a tourist drawcard, community interest in restoring giant clams to their reefs is high—coastal communities attest to a healthier marine ecosystem where giant clams are living, and they are careful to protect their restocked giant clams from poachers.

### HEALTHY COASTAL FISHERIES

How does ACIAR view its investment in giant clams, three decades later? Dr Chris Barlow, fisheries research program manager, says much has changed in the research approach, and today the focus would probably not be on a single species or group but on the broader ecosystem



PHOTO COURTESY: JOHN LUCAS

An early gathering of the giant clam project leaders at Bolinao Marine Laboratory. Edgardo Gomez is standing top right; Barney Smith, ACIAR fisheries program manager at the time, is seated far left.

within a community-based fisheries management approach. Nonetheless, he says: "We are seeing some very interesting outcomes. Communities are telling us that giant clams mean healthy coastal fisheries, so they have a role that wasn't anticipated as indicator species within successful community-managed marine areas." And he points out that without the aquaculture projects, these animals—which also have immense cultural value across the Pacific—would likely have been lost to communities, surviving only as rare exhibits in highly protected areas.

In the Philippines, the project helped lay the groundwork for one of the leading centres for coral reef research in the Pacific region, the University of the Philippines' Marine Science Institute and its Marine Laboratory at Bolinao. A new generation of marine biologists, taught and mentored by Professor Gomez, are entering a new phase of

research. Dr Patrick Cabaitan and Dr Cecilia Conaco recently published evidence of natural breeding of the restocked *T. gigas*, a breakthrough in itself but also, it is hoped, paving the way for new and exciting research on ocean circulation models based on movement of the giant clam larvae.

The best learning often comes from unanticipated results, and ACIAR is keen to better understand the outcomes of the giant clam projects. An impact study is under way that will hopefully unpick some of the complexities of the projects and identify any lessons that could feed into and improve the research system. ■

**ACIAR PROJECTS:** FIS/1983/032 and FIS/1987/033, 'The culture of the giant clam (*Tridacna* spp.) for food and restocking of reefs'

**MORE INFORMATION:** Dr Chris Barlow, [chris.barlow@aciar.gov.au](mailto:chris.barlow@aciar.gov.au)

# PEOPLE POWER KEY FOR REFORESTATION

Successful watershed rehabilitation in the Philippines requires more than just planting trees. Economic and social factors also play a crucial role

BY MELISSA MARINO

When Professor John Herbohn talks about reforestation in the Philippines, it is as much about the people within the forests as the natural environment. It is what he calls the “social landscape for reforestation” and getting its settings right by understanding the needs of communities is fundamental to the success of forest restoration efforts under way across the country.

Professor Herbohn is in a unique position to provide an insight into what these settings are. The University of the Sunshine Coast’s Tropical Forests and People Research Centre director has worked in the Philippines for 18 years, most recently as lead researcher on a five-year ACIAR project to improve watershed rehabilitation outcomes.

The recently completed project was expansive in scope. Several collaborating institutions and

PHOTO: NESTOR GREGORIO

Best practice on-site preparation adopted by the people’s organisation in establishing the pilot reforestation program.



dozens of researchers at multiple field sites looked at environmental, socio-economic and policy factors associated with successful reforestation. Alongside the wealth of data and journal articles they produced, the project found that community engagement is critical to reforestation.

“Our work is about how reforestation can benefit people and how people are fundamental to the success of reforestation,” Professor Herbohn says. “The two go hand-in-hand. Reforestation is about more than growing trees. It needs to be part of broader community development, satisfying the requirements of the people on whose land it is being implemented.”

These requirements include a biodiversity or conservation element, a production component for timber or seedlings, and a livelihood component including crops. Professor Herbohn’s research team tested systems incorporating all three: “For reforestation to be successful they have to be able to co-exist,” he says.

The Philippines has been deforested over decades through logging, land clearing and deliberate or accidental burning causing severe environmental degradation and resulting in tracts of unproductive land. It is an issue that the Philippines Government is addressing through the National Greening Program that aims to reforest seven million hectares over the next 12 years. The history of reforestation programs in the Philippines is chequered, however, with some successes but also failures.

Professor Herbohn says sometimes local people were not invested in reforestation: “Communities have been engaged to plant trees, but they’ve been treated more as contractors rather than stakeholders,” he says. “And because they have no real ownership of those trees, survival rates have been low due to the lack of plantation maintenance, especially when reforestation funds are exhausted.”

### THE BILIRAN SOLUTION

Professor Herbohn’s project embedded itself within the upland community of Barangay Kawayanon in Biliran Province—home to four past failed reforestation attempts. The community was engaged at every stage to implement a pilot rehabilitation program. Drawing on more than 15 years of research, the project team identified the key factors for successful community-based reforestation. First on the agenda was to establish a People’s Organisation (PO), comprising about 30 families, to define the community’s needs and help implement and run the research.

“The team worked with the PO for about a year before we even thought about planting a tree,” Professor Herbohn explains. “PO members were taught skills in record-keeping, running meetings and accounting to ensure the organisation was functional.”

With new knowledge in plantation



PHOTO: NESTOR GREGORIO

One of the regular meetings between the DENR, ACIAR project researchers and the people’s organisation to discuss project updates.

establishment and post-planting silviculture best practice, the PO worked with the researchers to decide what to grow and where to use a “landscape approach”, where different species are used in certain environments.

Some areas were planted with trees for conservation and rehabilitation, while others were earmarked for timber production. Cash crops such as pineapple, cassava and sweet potato were planted for agricultural production in designated community farms and around forested areas.

Professor Herbohn explains that crops around forest margins act as a buffer against fire and also encourage community fire prevention. “They want to protect areas producing food so if a fire does come along, people are highly motivated to deal with it,” he says.

To increase their livelihoods, the PO learnt about high-quality seedling production and established a nursery program, growing seedlings to supply not only the community’s reforestation, but broader rehabilitation across the Philippines.

The real-life setting has provided new insights into the practicalities of successful rehabilitation, which relies on community engagement and opportunities for financial returns at different stages of growth. “It’s been very much an action-learning process on a journey with the local community,” Professor Herbohn says. “And we have been really pleased with the way it has worked.”

Today, as the project is being finalised, the researchers are reporting impressive results. Not only are there environmental benefits, but the community is also thriving. Income is being generated through multiple channels, including agricultural crops and nursery seedlings. As the trees mature, opportunities will develop for timber products, including firewood from early harvest through to high-quality building materials in future years.

“Multiple products at different times during various production cycles provide a mix of short-term and long-term economic benefits for the community,” he says.

### NATIONAL IMPACT

Lessons from the Biliran pilot will now be taught more broadly, with the site to be used as a national example of successful reforestation. “It’s effectively a learning laboratory where people can see what best practices are and how they can be implemented,” Professor Herbohn says.

An understanding of the key socio-economic drivers for reforestation and the importance of building capacity and relationships between different groups will also be incorporated into recommendations to government.

The Philippines’ undersecretary for field operations, Mr Marlo Mendoza, says the Biliran pilot provides a valuable source of data for rehabilitation across the country. “The learning from that action research project is really very important in refining our National Greening Program,” he says.

For Professor Herbohn, these words indicate the research has had the impact he hoped for. “It sends a strong message that what we are doing is relevant,” he says. “Our work is very much about producing evidence-based policy and it’s been really fulfilling to have that research translated into policy that then has impact on the ground.”

This impact is possible thanks not only to the meticulous work of Professor Herbohn and his USC colleagues—Dr Nestor Gregorio, Associate Professor Jack Baynes and Professor Steve Harrison—but also through the relationships they have built over many years with Filipino researchers including Dr Ed Mangaoang and Dr Art Pasa from the Visayas State University, who have been the Philippines project coordinators on several projects, as well as the Philippines Department of Environment and Natural Resources (DENR), and other levels of government.

The project is also testament to ACIAR’s willingness to provide long-term support, Professor Herbohn says. “It’s very difficult to have a project that runs for three years and immediately have impact. It’s from that sustained engagement that the impacts really come.” →

# STRONGER COMMUNITIES PROSPER TOGETHER

A newly expanded extension program shows that in areas vulnerable to conflict, building a more resilient social fabric supports economic prosperity

BY MELISSA MARINO

An extension model associated with a rapid increase in economic prosperity and social cohesion has been trialed in areas vulnerable to conflict in western Mindanao and will now be scaled-up through further ACIAR funding.

The Livelihood Improvement through Facilitated Extension (LIFE) model has been piloted in a program led by Noel Vock over the past four years in collaboration with RMIT University, The Landcare Foundation of the Philippines Inc (LFPI), University of the Philippines Los Banos (UPLB) and University of the Philippines Mindanao (UP Min).

Based on its success improving livelihoods, the project managed by Melbourne's RMIT University will continue until March 2019 through partnerships with four local agencies: the Consortium of Bangsamoro Civil Society representing part of western Mindanao's Muslim minority, two municipal extension agencies and an agricultural training college.

Talks are also under way to test the model through a national government agency, the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD), which would allow for it to be introduced in other areas affected by conflict.

"This presents us with the opportunity to widen

out the extension model at both the local and regional level and potentially nationally," says Mr Vock. "And if we can be successful at that national level then it's a very significant outcome for the ACIAR project."

Working across six communities in western Mindanao, Mr Vock's initial project—co-managed by Dr Ken Menz and Mary Johnson and delivered on the ground by LFPI, the UPLB and the UP Min—saw livelihoods and social capital improve significantly.

"Not only did farmers earn more, it also strengthened linkages within the community that make them more resilient and potentially able to deal with conflict if it arises," Mr Vock says. "And links with local extension agencies were also improved, which is



A member of the people's organisation measuring a tree's diameter during training on the selection of mother trees.

**"WE WERE ABLE TO DEMONSTRATE THE TREES SIGNIFICANTLY BUFFERED THE IMPACTS OF THE TYPHOON. THE REFORESTED CATCHMENT HAD MUCH LOWER PEAK FLOWS, WITH MORE WATER ABSORBED INTO THE SOIL, AND SUFFERED FAR LESS EROSION."**

– Professor John Herbohn

## MULTI-PRONGED

Project impacts have been broad, reflecting the project's scope. Along with the capstone pilot community-based reforestation in Biliran, the project also ran several field trials looking at the environmental benefits of reforestation.

The role trees play in improving water within communities, for example, was shown through the analysis of paired catchments in Basper and Manobo. Planting trees improved base flow in streams throughout the year by improving infiltration. That was a significant impact—few other areas in the world have made similar findings. These infiltration benefits came into sharp focus when Typhoon Haiyan tore through the paired catchment sites. While devastating, it provided a rare opportunity to gather important information about the reforested site compared to its denuded counterpart.

"We were able to demonstrate the trees significantly buffered the impacts of the typhoon," Professor Herbohn says. "The reforested catchment had much lower peak flows, with more water absorbed into the soil, and suffered far less erosion."

In the wake of the typhoon, analysis of long-term research sites planted with varying tree species also provided vital information about reforestation design: "We found native trees suffered in general less damage than exotic species and that mixtures, particularly of native species, fared a lot better than monocultures of introduced species."

Another important lesson is that it is better to reforest smaller areas and do it well than to try to plant larger areas and do it poorly. This means putting money and effort into building capacity in communities and ensuring benefits flow back to them.

## THROWING FORWARD

In the next phase, researchers intend to examine the best way to replicate lessons from Biliran in other communities without necessarily having a resource-intensive project team in place for every step.

Project findings will also start to have an international impact, for example, informing the International Union for Conservation of Nature's (IUCN's) Bonn Challenge, which aims to reforest 350 million hectares worldwide by 2030.

Meanwhile the Biliran community has been so successful that the DENR has given it additional nearby land to reforest as part of its greening program, which will be managed by the PO with ongoing input from the Filipino collaborators who are heavily engaged with the community.

For all its work on social issues, the focus remains to simply "grow trees better". This includes learning how to grow the large number of native species that produce high-quality timber and understanding the combinations of species that perform best together.

Further work is also needed on production systems for subsistence farmers since the investment in research, capacity building and production is integral to the success not only of forest rehabilitation, but their own survival.

"Reforestation cannot simply be viewed from the biophysical perspective nor from the social perspective alone," Professor Herbohn says. "It's really about how trees and people interact." ■

**ACIAR PROJECT:** ASEM/2010/050: Improving watershed rehabilitation outcomes in the Philippines using a systems approach

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PHOTO: NOEL VOCK

An extension model based on building social capital also allowed participating farmers to tour farming sites that practice innovative farming techniques.

agencies is vital. In practice this means working closely with farmers in groups to build the social dynamic and provide them with greater control over decision-making, while ensuring communication is open and transparent.

#### STRENGTH IN COMMUNITY

In conflict-vulnerable areas, tensions simmer and sometimes boil over between people from different religious, racial, cultural and ideological backgrounds over access to land, water and other resources. In western Mindanao, Mr Vock says the project helped improve this dynamic. In one community, for example, relations had improved so markedly between Christian and Muslim farmers that they visited each other's farms for the first time.

The project also allowed farmers to not just hear about innovative farming techniques and alternative crops, but to tour to see these practices first-hand. This direct experience inspired changes in farming practices and better economic outcomes.

important for the impact to continue after the project ends.”

Two factors, he says, were essential to this success. First, a carefully selected facilitator—either from the community or closely linked to it—was engaged through LFPI to run the program with input from the community. This is a vital role because trust is such an important issue in areas affected by conflict.

Second, the program itself focused on not just one, but three elements of successful extension: technical innovation, improving social capital, and building sustainable partnerships with local agencies.

In conflict-vulnerable areas, Mr Vock says, building social capital and links between farmers and extension

One community, for example, successfully banded together to replace corn monoculture and destructive charcoal production with more sustainable and profitable mixed agricultural businesses, nurseries to grow trees for local reforestation, and a market stall to sell their produce.

“We have clearly shown that better economic welfare flows from building social capital—trust and the ability to work together,” Mr Vock says. “With this extension model, we have the potential for national ownership going beyond the end of the life of this project. It can be taken up by anyone because it is not rocket science, it is just basic, good community development.” ■

**ACIAR PROJECT:** ASEM/2012/063: Improving the methods and impacts of agricultural extension in conflict areas of Mindanao, Philippines

**MORE INFORMATION:** Noel Vock, [nvock@bigpond.net.au](mailto:nvock@bigpond.net.au)

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# THE PHILIPPINES' LANDSCAPE CHALLENGE

The Philippines is rich in steep, environmentally fragile landscapes, but that land can sustain farming communities given appropriate land use planning resources

BY GIO BRAIDOTTI

**W**ith more than half of the Philippines' land area sloped at angles exceeding 18%, the country faces extreme soil erosion, landslide and flash flooding challenges. Problems are compounded by heavy rain and land clearing associated with agricultural food production, with effects being especially damaging in river catchment areas (or watersheds).

The improper land use is not a function

of deliberate policy, but rather of inadequate land management resources and capacity. To help close the knowledge gap, an ACIAR team led by Dr Anthony Ringrose-Voase has applied CSIRO landscape and soil surveying technology to two catchments in the Philippines, one in northern Mindanao and the other on the island of Bohol, that are respectively 220 and 610 square kilometres in size.

In addition to CSIRO, the team involved the Bureau of Soils and Water Management and the International Council for Research in Agroforestry (ICRAF), as well as local partners in each catchment

including Bohol Island State University and the University of Science and Technology of Southern Philippines. Dr Ringrose-Voase explains that the team captured information about soil properties—such as stoniness, clay content and pH—at sample sites throughout the two catchments. By combining the data from the sample sites with landscape data for the whole catchment, they generated digital soil maps showing how soil properties change across the landscape. These maps reveal the soil attributes that might affect cropping, forestry or agroforestry in different parts of the landscape. This treasure trove of information

PHOTO: ANTHONY RINGROSE-VOASE

Rice fields below Mount Sumagaya, Misamis Oriental Province, northern Mindanao.

**“LOW INPUT FARMING SYSTEMS OFTEN DEGRADE THE LANDSCAPE OVER TIME.”**

– Dr Anthony Ringrose-Voase

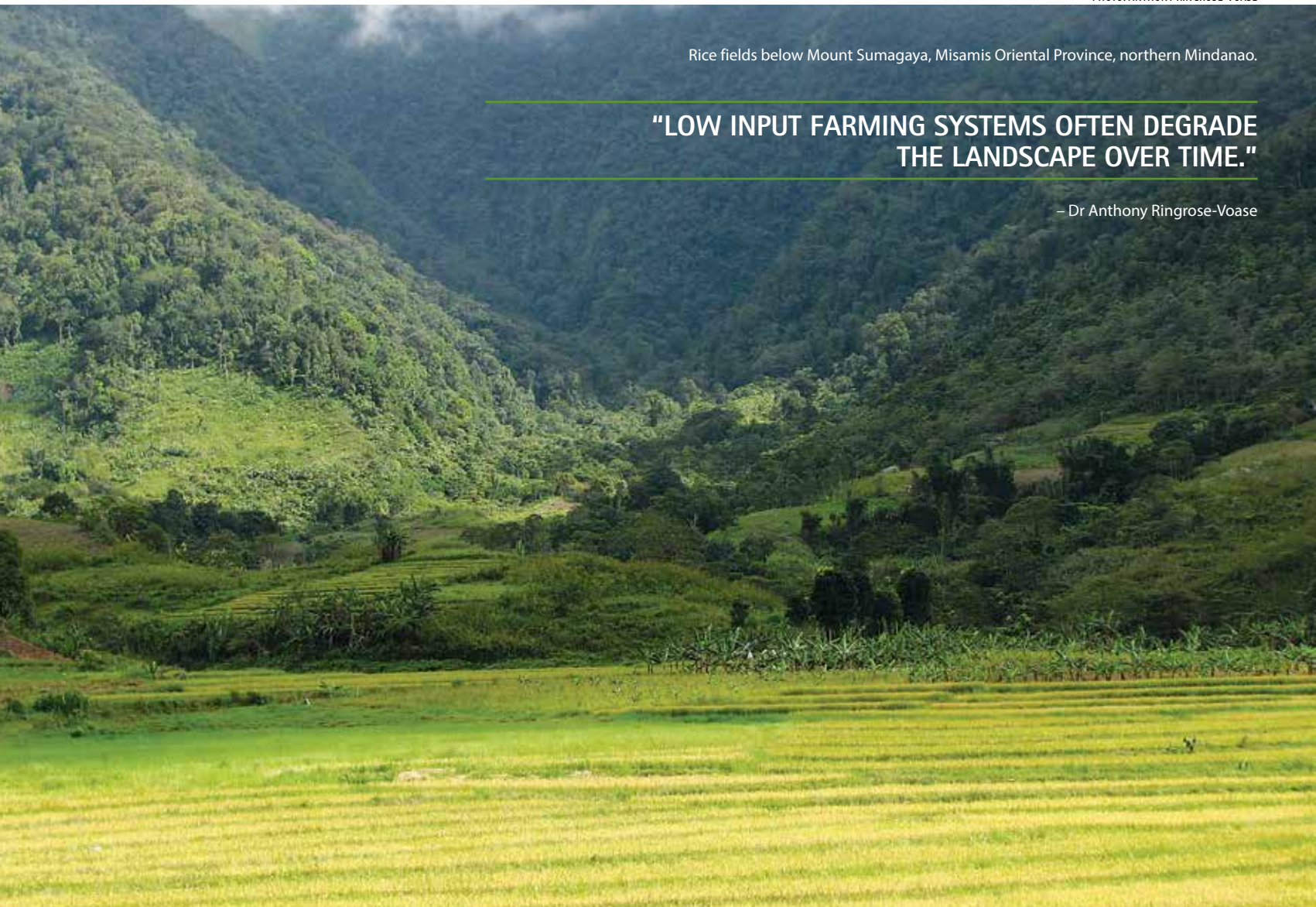


PHOTO: GERARD GREALISH



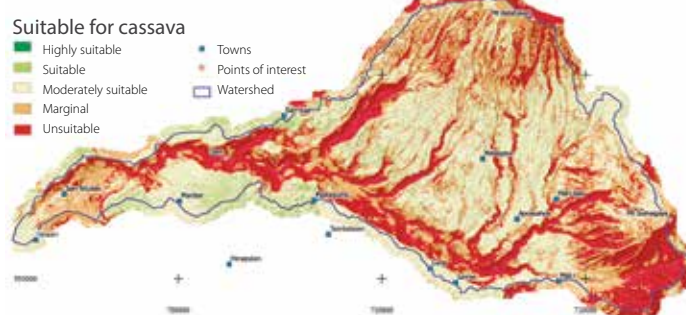
Mark Glover cataloguing a soil profile with young onlookers, Danao municipality, Bohol, during soil survey of the Wahig-Inabanga Catchment in November 2012.

PHOTO: GERARD GREALISH



Anthony Ringrose-Voase, CSIRO, in a fallow rice field in Sierra Bullones municipality during soil survey of the Wahig-Inabanga Catchment in November 2012.

**FIGURE 1** Land suitable for cassava in the Cabulig River Catchment, Southern Mindanao, estimated from maps of soil properties generated by the ACIAR project.



is now making it possible to identify land use practices best suited to both the needs of poor local farmers and the long-term sustainability of their delicate catchment environment.

"In upland watershed areas, you have farmers struggling to make a living so there is an imperative to improve livelihoods, but there is also an imperative to protect ecosystem services provided by the catchment," Dr Ringrose-Voase says. "Those environmental services are crucial to support farming productivity in the long term and to prevent flash floods and landslides while ensuring reasonably constant supply of clean water downstream."

Just after the project got under way, the value of environmental services was starkly illustrated. In 2011, Tropical Storm Sendong went through northern Mindanao and caused devastation to a neighbouring catchment, resulting in tragic loss of life at Cagayan de Oro. Poor catchment management contributed to flash flooding with many hundreds of victims being washed out to sea.

"The problems the farmers face are not just about slow degradation through soil erosion and soil fertility decline," Dr Ringrose-Voase says. "There can be very dramatic and disastrous impacts. So the imperative is huge to improve land use planning and the quality of environmental services provided by catchments."

### SUITABLE LAND USES

The land suitability maps have found applications during land use planning workshops attended by catchment stakeholders including local

government, farmer groups and a hydroelectric company. These make it possible to rationally target areas for on-ground action, such as prioritising areas for conversion from cropping to agroforestry.

During planning activities, Dr Ringrose-Voase stresses that it is vitally important to also engage at the village scale. "Farmers need to understand the planning process and contribute to it, including with regards to their own aspirations. This is essential for the plan's implementation and its long-term efficacy. To that end, participatory land use planning workshops were also held in a number of focus barangays (or villages) to develop more detailed plans with the village community."

Land use planning has a lot to offer farming communities as it can identify farming systems and crops with the potential to improve livelihoods. The trick is to incorporate consideration about the landscape's fragility into practices that improve farm productivity. It can prove a delicate balancing act.

For example, at the catchment scale, the maps can identify areas that should be targeted for reforestation and programs can be envisioned where farmers are paid to plant the trees. The participatory land use planning process, however, can reveal socio-economic fault lines that can undermine the intervention if left unresolved. In this case, once the planting is completed, the loss of income to farmers and lack of investment in the trees could see trees eventually harvested for their wood and the land returned to unsustainable farming practices.

"Sustainable intermediaries that provide both economic necessities and environmental services are possible," Dr Ringrose-Voase says. "One example is agroforestry. It provides a compromise solution, with trees helping to stabilise landscapes while also providing farming communities with livelihoods from tree crops, such as rubber, cacao and coffee. That strategy is especially useful for vulnerable areas."

At the other end of the scale, the project can identify areas where more valuable or nutritious crops are a realistic possibility for farmers, with the new land resource information helping to reduce risks to farmers when adopting new crops and farming practices.

One example cited by Dr Ringrose-Voase is a remote area in one of the catchments that grows low-value corn. The land suitability assessment revealed the area was suited to the cultivation of higher-value vegetable crops, but only if upgrades were made to the road linking the farmers to markets.

Conversely, where alternative farming systems are being considered, such as agroforestry with rubber, the land use maps may reveal that the soils at the targeted sites are unsuitable, since rubber is sensitive to alkaline pH—one of the soil attributes surveyed by the ACIAR team.

"While land information provides opportunities for innovation to both farmers and local authorities, it also prevents costly mistakes," Dr Ringrose-Voase says.

Ultimately, the project seeks to properly benefit impoverished smallholder farmers in remote areas who are often struggling without even the certainty of land tenure. Given their inability to invest in their farming system, they are tied to low-input and low-risk farming systems. And therein lies the problem: "Low input farming systems often degrade the landscape over time," Dr Ringrose-Voase says.

"You see that in many parts of the southern Philippines in the form of cleared hills, that have been farmed until soil fertility was exhausted and the soil eroded until farmers are forced to abandon the land. Those landscapes become grassland that is unproductive and offers limited protection from soil erosion." With the introduction of modern land suitability analysis, the ACIAR team has given the Philippines the ability to plan for both more sustainable and profitable practices into the future. It is also an invaluable tool for ACIAR and its own future engagement with some of the Philippines' most vulnerable smallholder farmers. ■

**ACIAR PROJECT:** SMCN/2009/031: Watershed evaluation for sustainable use of sloping agricultural land in the southern Philippines

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## ACIAR'S VISION

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

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



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Back cover:  
Tacloban farmers are proud of their achievements following vegetable farmer field school training delivered by East West Seeds as part of ACIAR's vegetable project.