

Country Profile

**Papua New
Guinea**

November 2006

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

© 2006 Australian Centre for International Agricultural Research
GPO Box 1571 Canberra ACT Australia 2601

ACIAR. *Country Profile: Papua New Guinea*. 2006.

ISSN 1449-9452 (print)

Additional copies of this publication are available from ACIAR offices—

In Papua New Guinea:

Dr Jacqui Wright
Manager Papua New Guinea
Tel: +675 325 9333 ext 299
Fax +675 323 5296
Email: Jacqui.wright@dfat.gov.au
Postal address:
Australia High Commission
Locked Bag 129
Waigani NCD
Papua New Guinea

In Australia:

Communications Program Manager
Tel: +612 6217 0500
Fax: +612 6217 0501
Email: comms@aciar.gov.au
Postal address:
GPO Box 1571
Canberra ACT 2601

Website: www.aciar.gov.au

Printed by Elect Printing, Canberra

Contents

Preface	3
Papua New Guinea Report 2005–06	5
Papua New Guinea Plan 2006–07	13
Active projects at 30 June 2006	18
Concluded projects 1 July 2005 – 30 June 2006	96
Projects under development at 30 June 2006	130
Papua New Guinea consultations	131
ACIAR publications	1355

Preface

The ACIAR Country Profiles are designed to give a snapshot of the collaborative research being carried out between Australia and our key partner countries. This publication contains short summaries of both bilateral and multilateral projects with Papua New Guinea that were active at 30 June 2006. At that time there were 37 active bilateral projects and 4 active multilateral projects, the latter being led by international agricultural research centres. There were another 26 projects under development, many of which are expected to start in 2006–07 financial year.

This publication also sets out the key outputs and outcomes from 14 bilateral projects and 1 multilateral project that have been completed at 30 June 2006.

In addition to these project summaries, the publication includes an extract from ACIAR's 2005–06 Annual Report covering Papua New Guinea, our near-term program as outlined in the 2006–07 Annual Operational Plan, and a record of the most recent consultations held between ACIAR and Papua New Guinea on the medium-term priorities for the joint program.

ACIAR updates this profile each year and distributes it to key stakeholders in Papua New Guinea and Australia.

We hope you find the publication useful as a record of the ongoing progress and achievements of ACIAR's collaborative research and development program with Papua New Guinea. For information on ACIAR's overall program, we invite you to visit our website at www.aciar.gov.au.



Peter Core
Director

November 2006



Jacqui Wright
ACIAR Country Manager, PNG
jacqui.wright@dfat.gov.au

Papua New Guinea Report 2005–06

(extract from ACIAR Annual Report 2005–06)

Active projects in 2005–06	54
AOP budgeted expenditure in 2005–06	\$4,490,000
Actual bilateral country expenditure in 2005–06	\$4,704,653
Bilateral country expenditure in 2004–05	\$4,226,822
Bilateral country expenditure in 2003–04	\$3,346,297

Key performance indicators	Performance 2005–06
Enhanced focus in project portfolio on improving the processing quality of commodities	Two projects initiated that emphasised coffee processing quality: ASEM/2004/017 <i>Assessment and improvement of quality management during postharvest processing and storage of coffee in Papua New Guinea</i> and ASEM/2004/042 <i>Assessing and extending schemes to enhance the profitability of the PNG coffee industry via price premiums for quality</i> .
Linkages between at least three ACIAR projects and three AusAID-funded PNG Agricultural Innovations Grant Facility (AIGF) projects established	ASEM/2004/042 is linked with AIGF1015 <i>Coffee growers/farmers production and marketing groups</i> ; CP/2003/029 is linked with AIGF 1125 <i>Management of potato late blight in PNG</i> ; ASEM/2001/037 is linked with AIGF1072 <i>Enhancing the capacity of village extension workers and contact farmers in the Wagih Valley of WHP and selected EHP to improve income from production and marketing of horticultural crops</i> .
Greater involvement of PNG University of Technology in ACIAR's program, including linkages to other PNG research institutions	An ACIAR scholarship scheme has been implemented to allow PNG nationals to undertake postgraduate training in-country while linking to ACIAR projects. UNITECH is also now directly involved in four ACIAR projects: ASEM/2004/047, ASEM/2001/037, LPS/2005/094, ASEM/2000/162.
Assistance with the institutionalisation of participatory action research (to focus research on smallholder needs)	PNG agricultural research institutions have traditionally been confined to on-station research. Through embodying participatory action research within most (9) of the projects commenced during 2005–06 projects and through delivery of two training courses, ACIAR has helped to change the philosophy of those institutions.
Increased emphasis on sweet potato research and development in ACIAR portfolio, commensurate with its importance as a staple food	CP/2004/071 <i>Reducing pest and disease impact on yield in selected PNG sweet potato production systems</i> will commence in June 2006. Two other active projects involving sweet potatoes are SMCN/2005/043 <i>Analysis of biophysical and socio-economic constraints to soil fertility management in the PNG Highlands</i> and ASEM/2005/126 <i>Sweet potato workshop</i> . A detailed design was completed for another project, CP/2005/134 <i>Improving informal seed systems for sustainable sweet potato production under resource-poor farming conditions in PNG and the Solomon Islands</i> , for commencement in late 2006.

Key performance indicators	Performance 2005–06
<ul style="list-style-type: none"> Potential role of indigenous nuts in local economies defined 	<p>Promising outlook for the Galip nut clearly defined in the final report of project FST/2002/010 <i>Domestication and commercialisation of multi-purpose indigenous trees and shrubs for food and other products</i>. A new project FST/2004/055 <i>Domestication and commercialisation of <u>Canarium indicum</u> in Papua New Guinea</i> was initiated as a result, and is now under way.</p>
<ul style="list-style-type: none"> Extent and severity of nutritional disorders in oil palms and impact on yields quantified and suitable amendments identified 	<p>The industry has quantified the extent and severity of nutritional disorders of oil palm in the country. Nitrogen is the main yield-limiting nutrient throughout PNG, while potassium and magnesium deficiencies also limit yields in many areas. Suitable nitrogen-containing amendments or improved nitrogen-management practices have been identified. Suitable magnesium- and potassium-containing amendments and improved magnesium and potassium management practices are currently being assessed in field trials.</p>
<ul style="list-style-type: none"> Fingerling production and supply to inland fish farmers significantly improved in quantity and quality 	<p>Total fingerling production from the PNG Highlands Aquaculture Development and Extension Centre increased from under 45,000 in 2004 to approximately 100,000 in 2005. Quality also improved. Continued improvements in quantity and quality are expected in 2006.</p>
<ul style="list-style-type: none"> 40% of new projects designed to have significant farmer or policy-maker impacts within 5 years of completion 	<p>Five out of the nine new projects assessed by members of the In-House Review Committee to be designed to have significant impacts within 5 years of completion (projects CP/2003/042, ASEM/2004/041, FST/2004/055, FIS/2005/096 and LPS/2005/094).</p>

Position

Papua New Guinea (PNG) is ACIAR's second largest partner, and ACIAR's investment and commitment in PNG reflect the deep, long-term relationship between the two countries. ACIAR's program in PNG has increased significantly in recent years, based on a strategy of support for applied research to enhance smallholders' income. Based on the outcomes of a PNG-ACIAR consultation held in late 2004, in its research program for PNG for 2005–06, ACIAR has clustered projects under four programmatic themes:

- Applied research aimed to **maintain and enhance smallholder incomes**, with an emphasis on root, plantation, agroforestry and horticultural crops and aquaculture. The social and economic context of the research is emphasised, particularly with respect to involvement of women farmers
- Sustainable management** of land, forestry and fisheries resources
- Biosecurity**
- Institutional capacity-building, socioeconomics and project assessment**, through development of human and physical resources

The PNG program has a strong emphasis on capacity-building. Project designs include schedules for training and also package research results to facilitate uptake by farmers.

In 1998 ACIAR and AusAID resolved to develop and fund a set of projects of mutual interest, and this partnership continues today. In 2003 AusAID established the PNG Agricultural Innovations Grant Facility (AIGF), which supports small projects in PNG agricultural research and extension institutions. Many AIGF projects have connection with previous or current ACIAR-funded projects at these institutions.

Achievements

A project to find ways to improve yield, quality and/or economic viability of **peanut production** has assessed the status of the PNG peanut industry, studying postharvest storage, utilisation, marketing systems and the extent of aflatoxin contamination in peanuts. Researchers found widespread aflatoxin contamination in PNG peanuts and the data they collected will form the basis of solutions to remedy this serious problem. A survey in four major peanut growing regions revealed that peanuts ranked amongst the top five income-generating crops across all regions.

Trials of lines of peanut from ICRISAT in India have identified promising varieties with major yield advantage over local lines. These lines are now being evaluated/disseminated by the farmers themselves via the concept of a 'seed village' in various locations. The scientists successfully tested the APSIM (Agricultural Production Systems sIMulator) peanut model and this will aid future assessment of the peanut production potential and climatic constraints for yield and quality (aflatoxin risk) in target environments.

A **sweet potato** evaluation and multiplication project is in progress in six lowland areas of Madang province in the search for better sweet potato varieties for the farming sector along the PNG's north coast. Sixteen different varieties, selected with assistance from the National Agricultural Research Institute (NARI), are being trialled in around 72 sites during both wet and dry seasons. As well, four sequential trials will determine optimum harvesting time for all varieties. Around 250 farmers will also test the varieties and help to develop a list of high-yielding sweet potatoes appropriate for individual lowland conditions. In keeping with the importance of sweet potato as the major food crop in PNG, during 2005–06 a cluster of sweet potato projects was developed addressing major production, pest management and postharvest issues.

In studies to determine how to enhance the **profitability of the PNG coffee industry** researchers identified eight stand-out collaborative schemes for collecting, pricing and processing coffee. An analysis of marketing margins indicated that coffee growers in PNG receive between 68 and 80 per cent of the gross free-on-board (FOB) price (in Lae) for 'green bean' coffee, indicating that the processing/exporting sector is relatively efficient and that growers are receiving reasonable prices. But such margins are available only to growers in close proximity to the traders and processors. For growers located in more remote areas, transport costs may consume most of the margin.

To improve quality control coffee growers are being actively encouraged to sell cherry rather than parchment (where the flesh has been removed). By having control of the entire process—pulping, fermenting, washing and drying—the processors gain a finished product with very similar characteristics to plantation-style coffees. Thus opportunities are emerging for PNG coffee to enter the specialty market.

The program to enhance PNG smallholder cocoa production through greater adoption of disease control practices took a hands-on '**cocoa in the classroom**' approach. Trained farmers shared their knowledge with other farmers in their village in an 'apostle–disciple' system. At Tinputz on Bougainville, the training received by Joseph Toumo, a lead farmer, has enabled him to implement new management options in his cocoa block and to guide a group of at least 12 farmers who regularly come together to discuss their cocoa block management. Neighbouring farmers have introduced new techniques to reduce diseases on their own blocks, based on what they have learnt from Joseph.

Sugarcane has a centre of genetic diversity in PNG and West Papua Province of Indonesia, and this germplasm is a valuable breeding resource for the sugarcane industries of the world. Pest and disease surveys have collected data from which to determine the potential threats to this germplasm as well as threats to sugar cropping industries in Indonesia, PNG and northern Australia. Much more is now known about the distribution of many fungal, bacterial and viral diseases of sugarcane as well as the distribution of insect pests in the region. Ramu stunt, a disease unique to PNG, was widespread in that country and the insect transmitting the stunt has been found throughout PNG, on most Torres Strait Islands and on the Australian mainland at Bamaga. The diseases smut and leaf scald were found to have spread east from Java towards Australia and PNG. Another concern was the discovery of unknown types of sugarcane mosaic virus in Indonesia and PNG.

The **red banded mango caterpillar** has emerged as a pest of crops in recent years, and surveys have determined that where the caterpillar has established in PNG it has caused significant loss of fruit. Control by conventional chemicals, though effective, will be difficult and likely irrelevant to local communities. Trials of various pesticides also damaged green ant populations, and it may well be that spraying in the past has killed off these ant predators and contributed to the emergence of the caterpillar as a pest. The project has succeeded in developing a potential pheromone lure that will be of long-term benefit to Australia and PNG for pest monitoring purposes, with potential for its use in a 'lure and kill' strategy.

Work continued on approaches for the management of *Oribius* weevils, another major pest of horticultural crops in PNG. The information gained from collections has enabled an initial systematic revision of the genus *Oribius* and clarified which are pest species in the highlands. Researchers have shown that even modest insecticide control can yield substantial benefits (to citrus, capsicum, cabbage, coffee, strawberry and avocado yields)—both in terms of quantity and quality—for the local farming community. Posters in English and pamphlets in Tok Pisin, helping to identify the weevils and giving details of how to limit their damage, have been produced and distributed.

Taro is a major crop and staple food throughout much of the South Pacific. It is culturally and economically important (worth almost \$1.5 billion) and is considered vital to food security. Pests and diseases cause significant losses and if left unchecked will devastate crops. The **taro beetle** is one example. Project work in both PNG and Fiji has led to better pesticide application methods that reduce considerably the damage caused to taro corms by the beetle. The breakthrough that led to a high level of protection is to administer a second pesticide application after three months.

Information on disease and pest management and control options for pests and diseases of taro are available but not easily accessible. This in turn creates difficulties in containing outbreaks and managing quarantine. The development of a CD-ROM package, **TaroPest**, providing information about pest and diseases of taro in the South Pacific is under way, assisted by SPC's Plant Protection Service and regional quarantine experts.

A concerted effort has been made in recent years to improve productivity in the country's cocoa, coconut and oil palm industries and to find ways in which younger people and women can participate. The schemes introduced into the **oil palm industry** have led to a significant increase in oil palm production and brought considerable benefit to participants (see associated box for more details). In studies of **magnesium deficiency** in volcanic soils, the research team now has clear evidence that magnesium is indeed a limiting nutrient on young volcanic ash soils and is well into developing an improved diagnostic system that better reflects magnesium deficiency in oil palms. Also data are becoming available that will be of great value in determining the best locations and strategies for applying magnesium fertilisers.

Work continued in the project to improve the marketing system for **fresh produce** in the highlands of PNG. There was a shift in emphasis from the physical aspects of the marketing system to the human aspects of the system—buyer-seller relationships, farmer-to-farmer relationships, the marketing skills of farmers and access of women and young people to the fresh produce marketing system. Highlights of the year included shipping trials of perishable fresh produce by air from farmer groups in the Eastern Highlands Province to a wholesaler in Port Moresby, and development of a postharvest training manual for farmers.

Researchers studying **sago contamination** assessed the impact of collection and storage techniques on the fermentation events in the sago starch. They compiled a composite flow chart of sago production, and used it along with sociological data they gathered to list critical points for minimising microbial contamination—trunk storage, pith removal, starch extraction and storage and food preparation. The major contributor to sago starch contamination during harvesting and extraction appeared to be poor quality wash water.

Inland aquaculture research continued at Aiyura in Eastern Highlands Province. Good progress was made in increasing the supply of fingerlings available to smallholder farmers throughout PNG. Ms Hopa Simon, one of the project's Technical Officers, determined that high mortalities of genetically improved farmed tilapia (GIFT) fingerlings during transport were largely due to use of rainwater from tanks at Aiyura. By adding tiny amounts of salt to the rainwater, or using reservoir water, mortalities dropped significantly.

Trials have been under way to find ways to reduce the cost of **feeding chickens** in the local broiler industry. Researchers have been trialling a concentrate feed mixed with local feed sources, like sweet potato. This is a departure from earlier trials to find entirely local feed sources for the commercial feed sector.

In **forestry**, initial studies of a range of indigenous fruit and nut species in PNG (East New Britain), Solomon Islands and Australia have led to a project to test the feasibility of domesticating and commercialising the canarium nut (*Canarium indicum*). The nut is a popular food and supply falls well below demand. Selecting cultivars that produce nuts regularly and fruit heavily will close this gap. The aim is to establish robust nursery propagation techniques suitable for community and village uptake. A more regular supply of high-quality fresh nuts can generate opportunities for smallholder farmers and underpin the development of a marketing network.

In the search for sustainable management of **timber stocks** in PNG's forests, researchers have undertaken a comprehensive review of current methods for strategic and operational forest inventories in PNG. They have also reviewed existing growth models for potential application to PNG forests. Improvements of PERSYST, a database system for the management of permanent sample plot data, will enable them to develop and maintain a high quality, reliable database of permanent sample plot data for PNG. The project has the potential to enhance the scientific understanding of stand dynamics, growth and yield, and many other issues in forest planning of tropical rainforests, both in PNG and elsewhere.

Mastotermes, a termite that causes massive damage to timber structures in northern Australia, has also been found in PNG. Attempts to eradicate infestations around Lae in the 1970s seemed successful but large nests have more recently been found around the Angau hospital and another site in Lae. ACIAR funded a study that mapped the extent of the infestations. The scientists determined that 1.4 km² was affected in total, far larger than the earlier infestations, but concluded that the wetness of the soil and position of some major drains seemed to impede the termites' spread. The investigators believe that the sites can be effectively treated with fipronil, a slow-acting termiticide carried by the termites through the colonies to a distance of 50 metres. Fipronil was not available during the earlier eradication attempt.

Progress has continued in establishing **science communication** proficiency in PNG. The SciCom course now has comprehensive workbooks and facilitators' guides for all modules. Accreditation of the SciCom course as the Graduate Certificate in Communication of Science and Technology through the Department of Language and Communication Studies (LCS) at Unitech is an important step towards sustainability.

Mobile card is on the move

In West New Britain, out-growers, those who independently grow oil palms outside of the company plantations and who sell fresh fruit bunches (FFBs) to companies, are an integral part of the oil palm scheme. Settlers commonly farm around 6 hectares—4 hectares planted with oil palm and 2 hectares of food gardens. In addition, village groups and individuals grow oil palms on their own customary land. Oil palm is the crop of choice, due to its robust yields and economic returns.

ACIAR funding has helped to increase women's participation in the oil palm industry in the province through the refinement of ownership and labour payment arrangements. In the Lus Frut Mama Scheme women were paid to collect fallen palm fruit that would otherwise have gone to waste. A feature of the scheme was the introduction of a 'Mama card' as 'currency' to manage payments more fairly and efficiently.

The success of this pilot scheme led researchers to extend its principles. Thus in 2002 began a trial of a new payment initiative, the Mobile Card, based on the Mama card and designed to facilitate family and caretaker labour participation and to promote mobility of hired labour between blocks by guaranteeing payment of the workers. But rather than being paid in cash by the blockholder, the worker is paid a proportion of the FFBs recorded on the Mobile Card. This payment system is now integral to the fruit payment system in New Britain Palm Oil (the largest buyer/processor) and is currently being implemented by Hargy Oil Palm, Bialla.

For the Mobile Card trial the researchers targeted 'problem' blocks with a history of low production and/or disruptive family conflict. The likelihood of success of the trial on such problem blocks was not great, so researchers were gratified when in many cases the Mobile Card overcame conflict and payment problems. An example of the Card's success concerns Elizabeth, a widowed leaseholder whose adult sons had moved away. After the death of her husband around 1990, Elizabeth and her young children were harassed on the block by local youths and petty thieves. She decided to leave the block and moved to an adjoining one where they were better protected. The condition of her block deteriorated, and the marketing of garden foods and betel nut became the family's primary income source.

In October 2002, when Elizabeth first employed a Mobile Card worker, her block was infested with weeds, creepers and small shrubby trees. Most of the palms planted in 1985 had not been pruned or managed for almost a decade. Production was extremely low—from January to September 2002 it was only 1.19 tonnes, an average of 0.13 tonnes per month. The employment of workers through the introduction of the Card has enabled her to bring the block back into production—by contrast, production from October 2002 to September 2003 was 32.3 tonnes, of which 57 per cent was weighed on the Mobile Card. Monthly production average rose to 2.7 tonnes. Areas that had fallen into disuse were being made ready for replanting and by August 2003 all her outstanding debt had been repaid.

For Elizabeth, the benefits of the Mobile Card have been substantial. Her monthly income has improved greatly and she now feels she has greater long-term income security and will no longer need to rely on her neighbours. Her goal, to build a permanent house on her block, is now attainable.

Papua New Guinea Plan 2006–07

(extract from ACIAR Annual Operational Plan 2006–07)

GNI per capita ¹		Bilateral actual 2004–05*	\$4.06m
Population ²	5.9 million	Bilateral forecast 2005–06*	\$4.49m
Population 2015/2050 ³	7.0/ 10.6 million	Bilateral budget 2006–07*	\$4.22m
Active bilateral projects ⁴	31	Bilateral + Multilateral	
Active multilateral projects ⁵	1	budget 2006–07	\$4.61m

*Includes AusAID-funded projects: \$2.14m (actual 2004-05), \$2.47m (forecast 2005-06), \$2.08m (budget 2006-07).

Medium-term strategy

ACIAR's strategy in Papua New Guinea (PNG) is to support applied technical and economic research aimed at the enhancement of incomes for smallholders and the broader community. The social and economic context of the research is emphasised, particularly with respect to involvement of women farmers. There is an emphasis on root, plantation and horticultural crops and fisheries. This includes both export crops and domestically traded crops that generate smallholder income, along with support for improved food security. Project design encourages private sector, industry and non-government organisation (NGO) linkages. Sustainability of renewable resources is encouraged through programmatic emphases on biosecurity and on sustainable management of forest and fisheries resources. The PNG program has a strong emphasis on capacity building, with high priority both to training within projects and postgraduate training. ACIAR will also link closely with relevant AusAID programs in PNG, particularly the new PNG Agricultural Research and Development Support Facility, programmed to commence in 2006–07.

Key performance indicators (2006–07)

- Enhanced focus in project portfolio on improving the quality of commodities
- Maintain linkages between at least three ACIAR projects and three AusAID-funded Agricultural Innovations Grant Facility projects
- Greater involvement of PNG University of Technology in ACIAR's program
- Increased emphasis on sweet potato research and development in ACIAR portfolio, commensurate with its importance as a staple food
- Potential role of indigenous nuts in local economies defined
- Extent and soil fertility decline of PNG highlands quantified and suitable research and development investments to improve soil fertility implemented
- A major thrust in support of the development of inland aquaculture consolidated, with increased coverage geographically and new attention to promising indigenous species
- Fingerling production and supply to inland fish farmers significantly improved in quantity and quality
- 40 per cent of new projects designed to have significant farmer or policy-maker impacts within five years of completion

¹ Source: Commonwealth of Australia, *Australia's Overseas Aid Program 2006-07*, Statement by Minister Alexander Downer, May 2006.

² Source: United Nations Population Division, 2005, *World Population Prospects: The 2004 Revision*, http://www.un.org/esa/population/publications/WPP2004/World_Population_2004_chart.pdf.

³ Source: United Nations Population Division, 2005, *World Population Prospects: The 2004 Revision*, http://www.un.org/esa/population/publications/WPP2004/World_Population_2004_chart.pdf.

⁴ For all country chapters this figure indicates active bilateral projects as at June 2006.

⁵ For all country chapters this figure indicates active multilateral projects as at June 2006.

Position

Papua New Guinea is one of ACIAR's most important partners. ACIAR's investment and commitment in PNG reflects the deep, long-term relationship between the two countries. Overall, PNG is Australia's largest development partner. Australia is committed to seeing PNG develop and prosper. ACIAR's program in PNG has endeavoured to reflect this and over recent years the portfolio has increased significantly. Since 1998, ACIAR and AusAID have worked and continue to work together to develop and fund a set of projects of mutual interest, through a Record of Understanding which provides funding of \$ 2m annually for support of bilateral projects. In 2003, AusAID established the PNG Agricultural Innovations Grant Facility (AIGF), which supports small projects in PNG agricultural research and extension institutions. Many of these projects relate to previous or current ACIAR-funded projects at these institutions. ACIAR will link closely with the new AusAID-funded PNG Agricultural Research and Development Support Facility, programmed to commence in 2006–07.

PNG faces some formidable challenges to its agricultural development. It is a net food importer with high population growth rates. Village-based agriculture supports 70–80 per cent of the population, and domestic trading of fresh produce is a very important source of cash income. By far the most important crop in PNG is sweet potato. Other root crops are also important but well below sweet potato. The main cash crops in order of export value are oil palm, coffee, cocoa and coconuts. Domestic trading of fresh produce is a very important (and often under-recognised) source of cash income. Domestically marketed food is second to oil palm in value to the economy. Forestry is PNG's third largest revenue earner and a major contributor to the overall economic and social development of the country. The PNG fisheries zone of 2.4 million square kilometres is the largest in the South Pacific. The fisheries zone includes an extended reef system, numerous islands and an extensive coastline. These create huge opportunity but also present an enormous challenge for monitoring and control. The total market value of the PNG catch is estimated at AUD140–160 million.

ACIAR's program recognises the many challenges to agricultural development in PNG, including poorly developed infrastructure, weak market signals and services, poor product quality, population pressure and future impacts of HIV/AIDS on the farming sector. Major changes to the rural environment over the last decade include greater exposure to global markets, devaluation of the Kina, pressure on land and renewable resources as a result of population increases, and new pest and disease threats. These mean that as well as making a greater commitment to the implementation of the results of research, the need for on-going development of agricultural technologies remains strong.

ACIAR has funded some highly successful projects in PNG. Examples include control of the plant pest banana skipper and identification of the pheromone of cane borer (enabling its numbers to be monitored in the field), research on halting the spread of bee mites in PNG, conservation of indigenous plants, and management of the tuna industry. Much effort has gone into land-use planning and supporting policy development for PNG's food security. PNG's relative lack of resources and expertise is a constraint in R&D activities and in delivery of extension services. It is therefore crucial, when designing projects, to include training and packaging of research results in a form suitable for uptake by farmers.

Relationship to the AusAID PNG strategy

AusAID's program supports broad-based sustainable economic growth in PNG by working with PNG government agencies and systems to ensure better use of PNG's own resources to strengthen economic management, deliver essential services and improve law and order. The importance of strengthening political governance, building sustainable government institutions, exploiting opportunities to stimulate sustainable economic growth and maintaining service delivery is recognised.

ACIAR's PNG program, which is delivered with significant long-term AusAID co-funding, supports the emphasis on fostering economic growth by working with PNG government agencies and systems. Partnership with PNG public and private sector institutions in agricultural research and development supports better use of PNG's own resources. With over 85% of the population in rural areas, development of agricultural industries and the smallholder cash economy is critical in stimulating sustainable economic growth and in maintaining service delivery.

Indicative priorities and current project portfolio

ACIAR has a formal program of consultations with PNG to establish priorities in research collaboration. These consultations are on a four-year rolling basis and were last held with PNG in September 2004; a record of the consultations is provided at www.aciar.gov.au under Partner country priorities/Papua New Guinea.

At the consultation, consensus was achieved on several overarching issues. These include the roles of the private sector, industry bodies and NGOs along with government in research and implementation of research results, and the importance of research that assists the engagement of smallholders in the cash economy. In a discipline sense, the ACIAR PNG portfolio will emphasise agricultural economics (including after harvest activities), farming systems, crop protection, fisheries and forestry.

The priorities are grouped under four programmatic themes:

1. Applied research aimed to maintain and enhance smallholder incomes, with an emphasis on root, plantation, agroforestry and horticultural crops and aquaculture. The social and economic context of the research is emphasised particularly with respect to involvement of women farmers
2. Sustainable management of land, forestry and fisheries resources
3. Biosecurity
4. Institutional capacity building, socioeconomics and project assessment, through development of human and physical resources

Subprogram 1: Enhancement of smallholder incomes from agriculture

A. Social and economic constraints and opportunities

- Research addressing social, economic and policy constraints and opportunities in smallholder production systems
- Market chain analysis (including quality incentives) for key commodities
- Analysis of international comparative market advantage of selected PNG agricultural commodities

B. Root and horticultural crops

- Conservation, characterisation and utilisation of plant genetic resources (sugar, banana, taro, sweet potato, yam)
- Improved productivity and postharvest handling nutrition of products from smallholder farming systems, especially sweet potatoes and peanuts
- Management of pests and diseases of potato, sweet potato and other root crops
- Integrated crop management for highland vegetable production
- Maintenance of soil fertility with intensification of land use for annual crops

C. Tree crops

- Cocoa and coffee quality management, crop protection and marketing
- Management of key insect pests and diseases of perennial fruit and tree crops and oil palm
- Maintenance of soil fertility in response to intensification of land use for plantation crops

D. Village-based aquaculture

- Enhanced productivity of existing inland pond aquaculture systems, and investigation of new opportunities including the domestication of indigenous species.
- Assessment of market options and opportunities for aquaculture production

- Low-cost feeds and feeding systems for aquaculture.

E. Forestry and agro-forestry systems

- Domestication and improvement of multiple-use, fast-growing indigenous tree species for smallholders and plantation development
- Processing of wood and non-wood products for value adding and local industry development
- Improvement of traditional agroforestry systems, including fallow rotations, coffee, cocoa, vanilla cover crop management
- Development of non-timber forest products for communities

Subprogram 2. Sustainable management of forestry and fisheries resources

- Native forest management, including ecology of forest regeneration after logging growth and sustainable yield planning (with information and inventory systems) for forest harvesting
- Sustainable management for smallholder woodlots and industrial plantations, addressing soil and nutrient conservation, productivity decline, and forest pests and diseases
- Reforestation of degraded sites, including grasslands and mine sites
- Simple village-level mariculture options for enhanced livelihoods and to provide tools to support sustainable management arrangements for inshore fisheries resources
- Cooperation in the assessment and management of shared fish stocks in Torres Strait and the Gulf of Papua
- Review of policies and strategies for the tuna fishery
- Assessment of impacts of fish-attracting-device associated tuna fisheries on resource sustainability, particularly the capture of juvenile bigeye and yellowfin tuna

Subprogram 3. Biosecurity policy and capacity enhancement

- Capacity building for diagnosis and integrated management of plant pests, diseases and weeds
- Risk analysis and contingency planning for high-risk plant pests and livestock diseases

Subprogram 4. Institutional and individual capacity building

- Training priorities are mainly addressed through targeted activities within projects
- Support for Postgraduate degrees in Australia and an in-country scholarship scheme at Unitech, Lae.
- Purpose-designed in-country courses in:
 - experimental design and statistical analysis, including management of data quality
 - research management, priority setting, monitoring and evaluation and impact assessment
 - scientific proposal writing and project design
 - presentation for scientific, extension, farmer and government audiences
 - collection and analysis of market information and training in extension approaches, including farmer participatory action research.

Key program managers

Dr Ken Menz, Agricultural Systems Economics and Management
 Dr TK Lim, Crop Protection
 Mr Barney Smith, Fisheries
 Dr Russell Haines, Forestry
 Dr Jeff Davis, Policy Linkages and Impact Assessment

Country Manager

Dr Jacqui Wright, ACIAR Country Manager, PNG and Solomon Islands

Active projects

at 30 June 2006

Bilateral

AH/2001/054	The identification of constraints and possible remedies to livestock production by zoonotic diseases in the South Pacific	20
ASEM/2000/162	Scientific communication in Papua New Guinea	22
ASEM/2001/016	Microbial contaminants associated with sago processing and storage in Papua New Guinea	24
ASEM/2001/037	Improving the marketing system for fresh produce of the highlands of PNG	27
ASEM/2002/014	Improving productivity and the participation of youth and women in the Papua New Guinea cocoa, coconut and oil palm industries	29
ASEM/2002/050	Economic performance and management of the Gulf of Papua prawn fishery	31
ASEM/2003/010	Farmer evaluation and multiplication of sweet potato varieties on the North Coast of PNG	33
ASEM/2003/015	Enhancing PNG smallholder cocoa production through greater adoption of disease control practices	35
ASEM/2004/011	Evaluating domestic tuna fisheries projects	37
ASEM/2004/017	Assessment and improvement of quality management during postharvest processing and storage of coffee in Papua New Guinea	39
ASEM/2004/041	Productivity and marketing enhancement for peanut in Papua New Guinea and Australia	40
ASEM/2004/042	Assessing and extending schemes to enhance the profitability of the PNG coffee industry via price premiums for quality	41
ASEM/2004/077	Postgraduate Scholarship Scheme for UNITECH, University of Lae, Papua New Guinea	43
CP/1994/043	Virus indexing and DNA fingerprinting for the international movement and conservation of taro germplasm	45
CP/1996/091	Biological control of <i>Chromolaena odorata</i> in Indonesia, Papua New Guinea and the Philippines	47
CP/2000/044	Taro beetle management in PNG and Fiji	49
CP/2002/013	Biology, damage levels and control of red-banded mango caterpillar in Papua New Guinea and Australia	52
CP/2003/029	Management of potato late blight in Papua New Guinea	54
CP/2003/042	Fruit fly management in Papua New Guinea	56
CP/2004/001	TaroPest: A computer based information and diagnostics package for taro pests of the South Pacific	57
CP/2004/064	Biological control of 'mile-a-minute' (<i>Mikania micrantha</i>) in Papua New Guinea and Fiji	59
CP/2004/071	Reducing pest and disease impact on yield in selected PNG sweet potato production systems	60
CP/2006/017	Management of <i>Eumetopina flavipes</i> : the vector of ramu stunt disease of sugarcane in Papua New Guinea	61

FIS/2001/075	Sustainable aquaculture development in Pacific Islands region and northern Australia	62
FIS/2001/083	Inland aquaculture in PNG: improving fingerling supply and fish nutrition for smallholder farms	66
FIS/2002/056	Biology and status of the prawn stocks and trawl fishery in the Gulf of Papua	69
FIS/2004/065	Culture of promising indigenous fish species and bioremediation for barramundi aquaculture in northern Australia and PNG	71
FIS/2005/096	Assessment of the impact of the PNG purse seine fishery on tuna stocks, with special focus on the impact of fish aggregation devices (FADs)	72
FIS/2006/001	Increasing capacity for regional fish feed manufacture in Papua New Guinea	73
FST/2003/049	Review of portable sawmills in the Pacific: Identifying the factors for success	74
FST/2004/009	Facilitating the availability and use of improved germplasm for forestry and agroforestry in Papua New Guinea	77
FST/2004/055	Domestication and commercialisation of <i>Canarium indicum</i> in Papua New Guinea	79
PLIA/2005/148	Papua New Guinea coffee and cocoa policy linkages scoping study	80
SFS/2001/036	Maximising the economic benefits to Pacific Island Nations from management of migratory tuna stocks	81
SMCN/1998/028	Diagnosis and correction of nutritional disorders of yams	84
SMCN/2000/046	Overcoming magnesium deficiency in oil palm crops on volcanic ash soils of Papua New Guinea	86
Multilateral		
ASEM/2004/047	Sustainable management of coffee green scales in Papua New Guinea	88
CP/2005/136	Mitigating the threat of banana <i>Fusarium</i> wilt: understanding the agroecological distribution of pathogenic forms and developing disease management strategies	89
CP/2006/051	Cocoa pod borer scoping study in PNG	90
SFS/2001/068	Technical support for regional plant genetic resources development in the Pacific	93

AH/2001/054: The identification of constraints and possible remedies to livestock production by zoonotic diseases in the South Pacific

Overseas Collaborating Countries	Fiji, Kiribati, Papua New Guinea, Tonga
Commissioned Organisation	Murdoch University, Division of Veterinary and Biomedical Sciences, Australia
Project Leader	Dr Simon Reid Phone: 08 9360 7423 Fax: 08 9310 4144 Email: s.reid@murdoch.edu.au
Collaborating Institutions	National Agriculture Quarantine and Inspection Authority, Papua New Guinea Secretariat of the Pacific Community, Fiji University of Melbourne, Australia Children's Hospital, Westmead, Australia Department of Agriculture, Fisheries and Forestry, Australia WHO/FAO/OIE Collaborating Centre for Reference & Research on Leptospirosis, Australia
Project Budget	\$555,579
Project Duration	01/01/2002 to 30/06/2007 (Project extended from 01/01/2006 to 30/06/2007)
ACIAR Research Program Manager	Dr Peter Rolfe

Project background and objectives

Most countries and territories in the South Pacific are experiencing a growing demand for animal products, as human populations increase and expectations rise for higher living standards. Greater intensification of animal production in areas with limited land resources has increased the possibility of human–animal contact, and thus the risk of zoonotic disease. Trichinellosis, leptospirosis and angiostrongylosis are the diseases of most concern in the region. Leptospirosis infection causes production loss in livestock and is a serious public health issue, especially for owners of livestock and workers in the processing industry. *Angiostrongylus cantonensis* infection is an unquantified threat to livestock health and is emerging as a serious public health problem. *Trichinella infection* in pigs is a barrier to livestock trade and could result in a significant loss to producers. If this organism entered Australia, it could cause severe economic losses to the Australian pork industry.

Zoonotic diseases (diseases transmitted from animals to humans) are thought to be increasing in the South Pacific as livestock production intensifies. The aim of this project is to determine the extent of the problem posed by zoonotic diseases, and to develop control strategies to reduce their impact.

Project progress

Year 4 (01/01/2005–31/12/2005)

The majority of the project extension activities will begin in 2006. There has been limited progress towards Objective 1 mainly because of delays in the finalisation of project documents for this extension. Preliminary discussions with cattle producers in the Markham Valley have been conducted and their cooperation achieved. The first survey is planned for May 2006.

Research activity to perform a cross-sectional survey of domestic pigs in PNG to prove freedom from *Trichinella* infection will commence in 2006. In 2005 a total of 327 crocodiles were screened for the presence of infection with *Trichinella* using the digest method. A total of 44 crocodiles were shown to be infected with *Trichinella* larvae, of which 27 came from Kikori, 12 from other locations and five were born on the farm. Larvae from the crocodiles from Ambunti (Sepik) were analysed at the International Trichinella Reference Centre, Rome and found to be genetically identical to larvae isolated from crocodiles from Kikori. These data suggest that Kikori is the only source of infected crocodiles at Mainland Holdings. In addition, meat from three wild pigs from Ambunti was also negative for *Trichinella* infection.

ASEM/2000/162: Scientific communication in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	University of Queensland, Australia
Project Leader	Dr Jeff Coutts Phone: 07 4638 9119, 0438 361 153 Email: jeff@couttsjr.com.au http://www.scicom.ac.pg
Project Web Site	
Collaborating Institutions	University of Papua New Guinea, Papua New Guinea Papua New Guinea University of Technology, Papua New Guinea Vudal University College, Papua New Guinea
Project Budget	\$1,387,120
Project Duration	01/01/2002 to 31/12/2006 (Project extended from 01/01/2005 to 31/12/2006)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Investigators have established the need to improve scientific communication at the tertiary level in PNG at undergraduate, graduate and post-study levels. While there have been some short scientific communication courses organised in PNG these have targeted practising scientists. This project is redressing the gaps in scientific communication training at the undergraduate level, and to further develop the confidence and skills of research scientists and of journalists who report on scientific issues to non-scientists.

This project aims to improve the overall effectiveness of all aspects of scientific communication within the scientific community of Papua New Guinea.

Project progress

Year 4 (01/01/2005–31/12/2005)

This project extension is focused on supporting the transition between the project and the institutionalising of the project outputs. During the initial project period (2002–2004) seven modules were developed to promote the development of Scientific Communication across universities and research and development agencies (and other groups) across PNG—as well as developing staff capacity within these institutions to maintain sustainability at the end of the project. These objectives were completed and Unitech in Lae accredited a Post Graduate Certificate in the Communication of Science and Technology.

During 2005, the Language and Communication Department (LCS) at Unitech (in which the course is embedded) ran a series of five modules resulting in 13 participants being ready for graduation in April 2006. One module has also successfully been used in the final undergraduate year with Forestry to support the student research project. The University of Goroka ran three modules (for high school teachers) and has a submission to its academic board to have their Post-graduate certificate accredited for 2007. The UPNG Senate approved a Graduate Diploma in Communication of Sciences and Technology which appeared in the handbook in 2006—this is yet to be activated. Material from the SciCom courses has been incorporated into courses being run by the Centre for Teaching, Learning and In-House Training.

Facilitation training has been undertaken across most universities, strengthening the pool of university staff available to be course facilitators. On-going gender activities (including a gender workshop at Unitech) and reporting have provided endorsement for the approach and direction for on-going inclusiveness as the institutions take the training forward.

The website has been further developed to support on-going networking including the capacity for participants and graduates to put papers in progress on-line for peer feedback. Further work is being undertaken to look at linking activities and initiatives between UoG, UPNG and Goroka.

LCS at Unitech is now managing the database and materials for courses run from that institution.

ASEM/2001/016: Microbial contaminants associated with sago processing and storage in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	James Cook University, Australia
Project Leader	Mr Jeffrey Warner
Collaborating Institutions	Queensland Department of Primary Industries and Fisheries, Animal Research Institute, Australia University of Technology, Department of Applied Sciences, Papua New Guinea University of Papua New Guinea, School of Humanities and Social Sciences, Papua New Guinea
Project Budget	\$549,858
Project Duration	01/07/2002 to 31/12/2007 (Project extended from 01/01/2005 to 31/12/2007)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Sago harvesting and consumption form an important part of the staple diet in selected areas of Papua New Guinea (PNG). However, this resource (in excess of 1 million hectares) is under-utilised. There is an estimated market for sago starch in PNG in excess of 12,000 tonnes (of which some is imported), and part of the international trade in starch (15,000-20,000 into Australia alone) at \$A150-200 per tonne could be filled by PNG sago. However the ability to satisfy these markets with high quality starch, essentially free of mycotoxins and food-borne pathogens is not assured.

Contaminant problems relate to the presence of mycotoxins in the starch which may cause sago haemolytic disease. This is prevalent in the main sago-growing areas to the south of the country, however its cause has never been resolved. Contamination of food with pathogenic bacteria and viruses is likely to be of a widespread nature, since the incidence of diarrhoeal disease is extensive and is caused by some of the same bacterial agents associated with contamination. This has been shown in experimental sampling from selected market sites. The extent and seriousness of sago contamination is not understood, nor indeed can it, until a more extensive investigation is mounted. Both contamination problems (fungal and bacterial), and the development of suitable solutions to them are of equal importance to the development of PNG sago as a village food and as a trade commodity.

This project is determining the causes and extent of health risks to consumers caused by contamination in village-produced sago in Papua New Guinea to identify options for reducing those risks and improving marketability of the processed sago.

Project progress

Year 4 (01/07/2005–30/06/2006)

Work to determine the significance and characterisation of haemolytic compounds derived from fungi isolated from sago starch has commenced. To date, the techniques to fractionate crude haemolytic extracts from *Penicillium steckii* have resulted in isolated bands of haemolytic activity which are awaiting further characterisation with high performance liquid chromatography. Techniques based on these methods have been prepared from other fungi with haemolytic properties. Techniques to determine the activity of these haemolytic fractions on red cell membranes have been optimised and await analysis with purified compounds. A Hazard Analysis and Critical Control Point (HACCP) study which guides the safe preparation and storage of sago starch in PNG is complete and initial plans for the publication of these points for village-based use is underway.

Objective 3. Assessment of mycotoxin contamination in sago samples and the potential of these mycotoxins to cause haemolytic disorders.

Activity 1. Activity directed fractionation

Development of purification and separation method by C18 SPE cartridges using 2 solvent systems one of Acetonitrile and the other with Methanol based on crude *P. steckii* hexane fraction. These separations provided a series of partially purified fractions which have been assayed for hemolytic activity. Hemolytic activity has been shown to be confined to 2 suspected bands on TLC plate. Further purification of these bands by HPLC has commenced.

Activity 2. Toxin characterisation

At this stage, little spectral characterisation of the hemolytic compound(s) have been undertaken, but will emerge as HPLC fractions are available.

Activity 3. Crude extraction

Crude extraction of hemolytic compound using *P. steckii* culture to develop an appropriate extraction and purification protocol for application to other fungi in sago. A working protocol using the non-polar fraction (unlike polar fraction for other mycotoxins showing hemolytic activity) has been adapted.

Activity 4. Activity directed fractionation

Initial screening of crude extracts for bands and hemolytic activity only. Investigations on hemolytic compounds to be pursued when suitable separation and detection method on HPLC developed.

Activity 5. Toxin characterisation

To be undertaken when Activity 4 is complete.

Activity 6. Red cell membrane Ghost SDS PAGE electrophoresis

The technique of red cell ghost preparation and protein separation with SDS PAGE has been optimised. The assay system is ready to test haemolytic fraction for specific red cell membrane activity when fractions become available (Activities 2 and 4).

Activities 7–10.

No progress—work planned outside this reporting period.

Activity 11. Transfer of technical skills to partner organisation

Mr Aisak Pue (University of Technology, Lae) commenced an AusAID-funded PhD program based at University of Queensland and DPI&F in March 2006. Aisak has received technical skills training in laboratory and bench work research. This involved extraction and purification, and included blood hemolytic activity assaying skills in PC 2 lab, plus Learning of instrumentation on HPLC and associated issues of efficient operation, time management and laboratory troubleshooting.

Activity 12. Transfer of appropriate technology to partner organisation

Aisak Pue has undertaken a series of courses involving learning of new methodology and research skills to be transferred in form of knowledge and skills transfer to PNG. This included learning literature searching using the University of Queensland subscribed web linkages for internet access of journals and other materials. It also included computer literature writing with Endnote linked referencing features. These skills have been demonstrated in the preparation of a comprehensive Literature Review (first draft submitted in June). Aisak also undertook AQIS training in April for *Certificate of Awareness* and *Certificate of Approved Premises*. These skills begin the technology transfer resulting from this project. Other skills/technology transfer will result from activity outside this reporting period.

Objective 4: Enhancement of HACCP training for strategic Unitech staff

Activity 13. HACCP training

Dr Betty Amoa successfully completed the Food Safety Management Systems Auditor/Lead Auditor Course (NCSI Training and Development) on 2 June 2006. Mr Pue will complete a similar program in 2007.

Activity 14.

No progress—work planned outside this reporting period

Objective 5: Recommend practical measures for reducing contaminants risk for consumers

Activity 15.

Develop and distribute a poster describing HACCP in relation to sago starch processing and storage in such a way that individuals within village communities can understand safe sago starch processing and storage

HACCP training and analysis has been completed. Dr Betty Amoa is engaging the services of the PNG Dept of Health to formulate appropriate language that can be used for poster development for village distribution.

Activities 16–20

No progress, work planned outside this reporting period

ASEM/2001/037: Improving the marketing system for fresh produce of the highlands of PNG

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	University of Canberra, Australia
Project Leader	Professor John Spriggs Phone: 02 6201 2317 Fax: 02 6201 2263 Email: john.spriggs@canberra.edu.au
Collaborating Institutions	National Agricultural Research Institute, Papua New Guinea Fresh Produce Development Corporation, Papua New Guinea University of Technology, Papua New Guinea
Project Budget	\$580,081
Project Duration	01/01/2003 to 31/12/2006 (Project extended from 01/01/2006 to 31/12/2006)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

The Papua New Guinea (PNG) highlands, home to about one-third of the national population, is characterised by subsistence agriculture and rural poverty. Soils are rich and productive. High-quality produce can be grown organically all year round in this area and produce from the highlands could meet the needs of PNG's coastal cities and supply offshore markets. It fails to do so because of an inadequate marketing system. Marketing is made difficult by the long and complex supply chains between producing and consuming regions, and there is a growing trend for supermarkets to source their fresh produce from offshore. An effective marketing system for fresh produce could provide a cash income, empower women (who are mainly responsible for the cultivation) and significantly improve the economic situation of PNG's highlanders. Improving the marketing system for produce from the highlands is a high priority of the National Food Security Policy of the PNG Government, and two producer groups have already been formed in the Highlands by farmers keen to improve their marketing of fresh produce.

The project is improving the marketing system for fresh produce grown in the temperate zone of the PNG highlands, by facilitating processes that will improve the supply chains by land, air and sea, and by enhancing the capacity of relevant people and institutions in PNG.

Project progress

Year 3 (01/01/2005–31/12/2005)

This is the third year of an **action research** project concerned with socio-economic change through community-based decision-making where the community of interest involves all the stakeholders in this marketing system. During the first two years of the project, the emphasis of stakeholders was on improving the **physical** aspects of the marketing system. However, during the third year (and in particular during the Project Extension phase), greater emphasis has been given to improving the **human** aspects of the marketing system. The main shift in emphasis came about during the second workshop held in April 2005 when much more attention was paid to the need to: (1) improve buyer-seller relationships; (2) build farmer-to-farmer relationships; (3) improve the marketing skills of farmers; and (4) improve the access of women and youth to the fresh produce marketing system.

By the time of this second stakeholder workshop, most of the concerns about improving the **physical** aspects of the marketing system were already being addressed through the development and implementation of a market infrastructure strategy (which involves consolidating fresh produce in the Highlands prior to movement down to coastal markets). However, there were still a couple of important issues around the physical aspects including: (1) the problem of securing access to land for

the consolidation depot in Goroka; and (2) the lack of a quality management system for fresh produce.

The main activities on this project during 2005 included:

1. Second stakeholder workshop (led by Professor Barbara Chambers) – April 2005
2. Development of proposals for three complementary projects aimed at improving the quality of fresh produce (written by Professor John Spriggs):
 - Development of whole-of-chain quality management system for fresh produce from the Highlands of PNG (conducted by the Department of Applied Science, Unitech)
 - Quality Improvement Project for Fresh Produce in Eastern Highlands Province (conducted by Smallholder Support Services Pilot Project (SSSPP) and FPDA)
 - Preservation and Storage of Perishable Fresh Fruits and Vegetables for the Highlands of PNG (conducted by the Department of Agriculture, Unitech)

These three projects have now been approved for funding. Projects (1) and (3) are being funded by ACIAR (as part of an extension to this project) and Project (2) is being funded by ADB.

3. Airfreight trials involving perishable fresh produce being shipped from farmer groups in the Eastern Highlands Province to a wholesaler in Port Moresby (conducted by FPDA)
4. Development of a concept paper re market infrastructure development—
5. Development of a post-harvest training manual for farmers (conducted by FPDA)
6. Survey of supermarket managers and Institutional Buyers in Lae and Port Moresby (conducted by NARI)
7. Completion of draft paper on “Increasing the autonomy of women as a means to improving community well-being and facilitating development: an exploratory study in the Highlands of PNG —
8. Presentation of Paper entitled ‘Think local before going global: understanding the consumer preferences for fresh produce in PNG Supermarkets’ (by Norah Omot, Jessie Anjen and John Spriggs) at the International Symposium on Supply Chain Management, Chiang Mai, Thailand.
9. Presentation of Paper entitled ‘Connecting people in cross-cultural agribusiness: the case of the fresh produce supply chain in PNG’ (by John Spriggs and Barbara Chambers) at the 2005 Development Studies Association Annual Conference in Milton Keynes, UK

Capacity-building of the PNG-based members of the research team took place primarily through the above R&D activities as well as the co-writing of conference papers. Prof. Spriggs also arranged specialised training for Mr. Vincent Hagulaha (the new Quality Management Officer, FPDA) at the University of Sydney as part of the project listed at 2(2) above and funded by ADB.

ASEM/2002/014: Improving productivity and the participation of youth and women in the Papua New Guinea cocoa, coconut and oil palm industries

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Curtin University of Technology, Australia
Project Leader	Dr George Curry Phone: 08 9266 3310 Fax: 08 9266 3166 Email: g.curry@curtin.edu.au
Collaborating Institutions	Cocoa and Coconut Research Institute, Papua New Guinea Oil Palm Research Association, Papua New Guinea PNG Cocoa & Coconut Extension Agency, Papua New Guinea
Project Budget	\$647,736
Project Duration	01/07/2003 to 30/06/2007 (Project extended from 01/07/2006 to 30/06/2007)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

A recent ACIAR-funded project promoted interventions in the smallholder oil palm sector of Papua New Guinea (PNG), including the increased participation of women in the industry through the 'Ius frut mama' card scheme. These interventions led to significant increases in smallholder productivity, and this project aims to replicate such achievements in the PNG smallholder cocoa and coconut sectors. Researchers are conducting an in-depth evaluation of a promising new payment system (also arising from the earlier ACIAR project) for oil palm smallholders at Hoskins, West New Britain and seek to further adapt it for other smallholder oil palm regions and for the smallholder cocoa sector in PNG. The project is designed to promote the sharing of knowledge and expertise between the key smallholder extension agencies and research organisations in the three industries.

Project progress

Year 3 (01/07/2005–30/06/2006)

This project aims to raise smallholder productivity in the cocoa and oil palm industries by: 1) improving the capacity of research and extension services; and 2) by introducing and testing new payment mechanisms for smallholders that enhance the participation of youth and women in cash crop production. The research to date has revealed that labour shortages in both cocoa and oil palm and poor block maintenance, especially in cocoa, are key constraints limiting smallholder productivity. A central factor limiting the supply of labour is the non-payment or under-payment of family and hired labour. The project is developing and testing initiatives to improve the remuneration of household and hired labour in oil palm and cocoa smallholder production.

The starting point for these initiatives was to identify the key principles underpinning the successful *Mama Lus Frut* Scheme introduced in 1997 in oil palm at Hoskins, West New Britain (WNB) where women were paid separately for the collection of loose fruit (ripe oil palm fruitlets). By guaranteeing women remuneration for their labour, women expanded their role in oil palm production, thereby generating considerable income and social benefits for themselves and their families. The principles underpinning the *Mama Lus Frut* scheme were then adapted for the payment of youth and hired labour through the 'Mobile Card Scheme' which was trialled amongst Hoskins oil palm smallholders. The Mobile Card involved paying family and hired labour a portion of the harvested fruit, thereby circumventing the problem of payment uncertainty associated with cash payments for labour. By guaranteeing payment of labour, disincentives to the mobilisation of family and hired labour were greatly reduced, thereby significantly raising smallholder productivity and incomes.

During 2005 and 2006 it was intended to adapt and trial the new payment initiative amongst cocoa growers in East New Britain (ENB) and to further refine and test the payment method amongst oil palm smallholders at Bialla, WNB.

In late 2005, work commenced amongst cocoa growers near Tokiala Plantation in ENB, in an initiative supported by New Guinea Island Produce (NGIP) (Tokiala Plantation is owned by NGIP). A baseline survey involving a demographic and livelihood survey was undertaken amongst smallholder cocoa growers who were to participate in a trial involving the private sector (NGIP) in the delivery of extension services including the testing of a new payment mechanism to raise smallholder productivity. However, the outbreak in ENB of cocoa pod borer (CPB) in early 2006 meant that the work on cocoa was suspended for the rest of the year as CCI focused all its efforts and resources on the eradication of this major pest. The work in cocoa will recommence in early 2007.

With the delay in the cocoa research program arising from the CPB outbreak, the new payment trial amongst oil palm smallholders at Bialla was brought forward. The Bialla trial builds on the Hoskins trail and includes: village oil palm (VOP) growers; blocks managed by 'caretakers'; labour-short blocks of elderly growers in the older land settlement subdivisions where replanting has been delayed; and labour-short blocks occupied by young families.

The earlier Mobile Card trial amongst Hoskins VOP growers revealed that some blockholders were reluctant to use the same contract labourer for an extended period to prevent the labourer building up 'ownership' rights in the block. To circumvent this problem, the Bialla trial is employing labouring groups on VOP blocks—youth, church and sports groups—because such contract groups do not undermine the tenure rights of the blockholder.

In February 2006 the Mobile Card trial began with the recruitment of two extension officers and the implementation of an awareness program amongst growers. By May 2006 Hargy Oil Palms Ltd had incorporated the percentage split between the blockholder and the Mobile Card worker into their smallholder payment system. In June 2006, 12 blocks were participating in the trial and this number will rise to 40 by the end of 2006. A preliminary assessment of these 12 blocks indicate that production and block management are steadily improving, and the new payment system introduced into the company payment system is operating successfully. The results of a visit to the Bialla trial by one of the CCI research collaborators to briefly assess the trial will be used in the design of the Mobile Card trial in the cocoa smallholder sector.

During the year progress was also made on examining strategies to improve the capacity of research and extension services in the cocoa sector. Two public seminars were held at CCI and with the Cocoa Board in ENB, outlining the results of the smallholder socio-economic studies and proposed recommendations to improve research and extension services. Feedback from these seminars is currently being incorporated into the draft smallholder cocoa report to be completed in January, 2007.

Also, fruitful discussions with the private sector have continued to assist in developing and evaluating new extension models involving partnerships between smallholder growers/customary landowners and the private sector. For example, in the cocoa sector, NGIP is servicing smallholders in ENB by providing planting materials, tools and extension advice. Thus, rather than limiting its activities to buying cocoa, as has been the case in the past, the company is now becoming more involved in supporting smallholders to raise productivity and increase or rehabilitate the area under cocoa production. This has the potential to substantially increase smallholder incomes, particularly in more remote areas where extension and support services are virtually absent.

In 2006 the research team visited WNB to assess similar models currently being established for cocoa growers by Kimbe Bay Shipping Agency (KBSA). These new forms of extension tend to be self-sustaining (largely self-funding), and they are raising smallholder productivity and improving the quality of product for international markets. As well as the social benefits arising from higher smallholder incomes associated with increased productivity, some of these new initiatives are also generating additional social benefits such as improved participation rates of women in export cash cropping and increased economic opportunities for rural youth.

Finally, the research team is currently organising, in association with the Cocoa Coconut Institute of PNG and the PNG Oil Palm Research Association, a joint one-day workshop in Port Moresby in March 2007 to 'showcase' successful initiatives in agricultural extension involving partnerships between smallholders and the private sector in PNG's main export tree crops.

ASEM/2002/050: Economic performance and management of the Gulf of Papua prawn fishery

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Australian National University, National Centre for Development Studies, Australia
Project Leader	Dr Thomas Kompas Phone: 6125 6566 Fax: 6125 5570 Email: tom.kompas@anu.edu.au
Collaborating Institutions	National Fisheries Authority, Papua New Guinea
Project Budget	\$269,487
Project Duration	01/07/2003 to 30/06/2007 (Project extended from 01/07/2006 to 30/06/2007)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

The Gulf of Papua Prawn Fishery (GPPF) is one of Papua New Guinea's most important fisheries. It provides a total annual catch of about 1000 metric tonnes, worth K\$10 million. Catch rates are low, largely due to the small number of vessels and their age. Fishing in the Gulf is overseen by the National Fishing Authority (NFA), which recently allocated 10 new licences for a small inshore prawn fishery. Little is known about the potential biological and economic impacts of the uptake of these licences. Crucial to this is the relationship between inshore and offshore components of the prawn population. NFA managers will be better placed to plan for sustainable management based on the best options, both economic and biological, with this knowledge. A previous ACIAR-supported project recommended a cap on industrial fishing and a change from management by Total Allowable Catch to Effort Targets. This is essential to managing the fishery, as is a greater understanding of the fishing power of the current and replacement fleets.

The project is analysing the economics of the GPPF fishery and the industry, to:

- document their economic status,
- assess economic performance,
- develop and evaluate management and policy options, and
- assess the impact of a small boat (inshore) fishery on the Gulf of Papua prawn fishery.

Project progress

Year 3 (01/07/2005–30/06/2006)

The economics component of this project (joint with a biology and stock assessment component) is now behind schedule, due to the repeated delay in establishing a stock-recruitment relationship by the biology team. This stock-recruitment relationship is a crucial part of the bioeconomic model. A preliminary stock-recruitment relationship was finally established at the annual workshop in Port Moresby, June 5 to 8 2006. Based on this preliminary relationship, the economics team has now developed estimates of 'maximum economic yield' for the fishery, establishing optimal effort and catch levels, based on the generic form of the bioeconomic model constructed last year in the project. The mathematical form and computer coding of the bioeconomic model as applied to the specific case of the Gulf of Papua Prawn Fishery (GPPF), based on this preliminary stock-recruitment relationship, has now been completed and thoroughly tested, with both the Principal Investigator in Australia and the Principal Investigator in PNG completely familiar with its construction and implementation. Final model results will be based on the final stock-recruitment model which should be available at the next planned workshop in October 2006.

Most of the economic data required to calibrate the bioeconomic model for the case of the GPPF has been assembled and verified. This has now been coded in Access and Excel format, and double checked for accuracy. With one or two exceptions, industry cooperation with data access has been very beneficial. Nevertheless, given the delay in the project, data now have to be updated to account for recent and dramatic increases in the price of fuel. A supplementary data set is now being constructed by the team in PNG for use in the estimate of final model results.

At the June 2006 workshop in PNG, considerable progress was also made by the economics team on the development of management objectives and policy options for the GPPF. Model results should now be completed in October 2006 and policy options based on these results will be articulated in a report and a planned workshop in PNG in November 2006.

ASEM/2003/010: Farmer evaluation and multiplication of sweet potato varieties on the north coast of PNG

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	World Vision Australia, Australia
Project Leader	Mr Jonathon Treagust Phone: 03-9287 2509 Fax: 03 92872377 Email: jonathan.treagust@worldvision.com.au
Collaborating Institutions	Australian National University, Australia World Vision Trust Pacific Division, Papua New Guinea National Agricultural Research Institute, Papua New Guinea
Project Budget	\$808,375
Project Duration	01/04/2004 to 31/07/2007 (Project extended from to 31/07/2007)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Papua New Guinea's (PNG) population is growing at a rapid rate, resulting in increasing land intensification, particularly for agriculture. As a result more productive crops are being planted, with sweet potato leading the way. The crop is now the most important for more than 60 per cent of the population, providing almost a third of total calories consumed. The possibility of future drought and increasing pressure on land use make the delivery of more productive lines important. In addition the wide range of agro-ecological zones in which sweet potato is grown makes the likelihood of finding varieties that are more suitable to localised conditions, offering yield boosts, high.

NARI has collected and trialled many crops and varieties that are likely to benefit farmers facing current yield constraints. A lack of clear line authority from national to provincial agricultural agencies has resulted in a sporadic extension of improved varieties. On PNG's north coast many communities stand to benefit from accessing improved varieties with more reliable output. Increased yields are likely to result in increased income, a reserve against drought and other disasters that often strike these areas. By evaluating and disseminating appropriate sweet potato varieties to the rural farming sector along the north coast of PNG the project is working to meet this potential.

Project progress

Year 2 (01/04/2005–31/03/2006)

The project operates in six lowland areas of Madang province, Papua New Guinea (PNG). Project scientists have selected 16 different varieties, with the assistance of the National Agricultural Research Institute (NARI), that are been trialled at approximately 72 technician-controlled sites during both the wet and dry season. Additionally, the project is also conducting four sequential trials to determine optimum harvesting time for all 16 varieties.

The project's progress and direction continues to be set by the Steering Committee Meeting held each quarter. The last one, held in March 2006, was attended by Dr. Sally Henderson, Elick Guaf (NARI), Abner Valu (NARI), project staff, farmers, Dr. Michael Bourke and Jonathan Treagust (WVA project officer). This meeting was particularly important for the next stage of the project—the Farmer Controlled trials. During this stage more than 250 farmer controlled trials will occur in both wet and dry season conditions to generate a list of high-yielding sweet potato varieties appropriate for individual lowland conditions. The farmers' evaluation of these varieties will be recorded and collated.

The project has now generated significant amounts of data on yield for each cultivar for both wet and dry season. The majority of this data has not been fully analysed. By the end of the **first Technician Controlled trial**, it was apparent that a number of varieties were clearly yielding well below expected levels and a number of varieties (K 142, MAS 2, L 942, L 46) gave consistently low yields (4–6 t/ha). This helped demonstrate that sweet potato has a more prominent 'genotype x environment' interaction than was originally anticipated.

One variety (SI 85) produced well at all six areas where the project is working. The mean yield for SI 85 across all 51 trials for which data were available was 15 tonnes/hectare. This is a reasonably good yield for lowland conditions. The mean yield of five other varieties (FV 2, FV 1, B 11, L 781, and SI 108) was also good (10–12 t/ha). One variety (KAV 61) gave very poor yields at all sites (mean less than 2 t/ha). Another four varieties (K 142, MAS 2, L 942, L 46) gave consistently low yields (4–6 t/ha). For many varieties, there is a marked genotype x environment interaction—that is, they performed well at some sites, but only moderately well or poorly at other sites.

Results of the **second Technician Controlled trial** have yet to be compiled or analysed.

ASEM/2003/015: Enhancing PNG smallholder cocoa production through greater adoption of disease control practices

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	University of Sydney, Faculty of Agriculture, Food and Natural Resources, Australia
Project Leader	Professor David Guest Phone: 02 9351 2946 Fax: 02 9351 4172 Email: d.guest@usyd.edu.au
Collaborating Institutions	Papua New Guinea Cocoa and Coconut Institute, Papua New Guinea MasterFoods Australia New Zealand, Australia Papua New Guinea University of Technology, Papua New Guinea
Project Budget	\$549,920
Project Duration	01/01/2005 to 31/12/2007
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Papua New Guinea's (PNG) cocoa sector supplies two per cent of the world market. Most of the total PNG crop comes from around 70,000 smallholders. The cocoa industry is worth an estimated K168 million (\$A87 million) a year based on 42,000 tonnes production. Smallholders usually grow cocoa as a supplementary income source, with few inputs and low costs reducing the impacts of market price fluctuations. One reason for the low input and production costs is the lack of applicability of cocoa management recommendations. These recommendations date back to when the plantation industry (not smallholders) was the dominant producer. When this industry sector was broken up smallholders emerged to take the place of plantation producers. The relevance of recommendations for management, including those for disease control, declined along with the plantation sector.

Productivity levels endured a similar, associated decline. One of the major causes was, and remains, diseases. Pod rot and canker caused by *Phytophthora palmivora*, vascular dieback streak and pink disease are the main inhibitors to productivity. New technologies, management approaches and resistant breeds against diseases are available but not widely adopted, or even known, among smallholders. Improving adoption of these approaches would significantly increase productivity and with it the income on offer to smallholders.

Project objectives are to sustainably increase the profitability of smallholder cocoa production in PNG through the development of effective and affordable strategies in partnership with farmers, and to develop effective management options of the major disease threats to production by:

- documenting disease losses and smallholder knowledge, skills and attitudes to disease management at selected district sites.
- fostering evaluation and adoption of a range of integrated disease management strategies in partnership with smallholders.
- enhancing research and development expertise and strengthening industry linkages

Project progress

Year 1 (01/01/2005–31/12/2005)

The first phase of this project was to document yields, disease losses and farmer skills and attitudes to disease management. The startup workshop held in Keravat in November 2005 attracted interest from cocoa stakeholders throughout PNG and Bougainville and enabled consultation with industry and almost 300 smallholders. Another workshop is now planned for Madang, and government agencies in Bougainville and New Ireland have expressed interest in holding workshops/field training days in association with agricultural field days later in 2006. The November 2005 workshop stimulated animated and extensive discussion of issues facing the industry.

More specific and targeted collection of baseline data is under way in East New Britain, Madang, West New Britain and Bougainville. The baseline survey questionnaire has been finalised, with input from George Curry and Gina Koczberski (ASEM /2002/014), and information is now being collected prior to establishment of on-farm and PAR trials. John Konam and his team have discovered that it is more effective to spend time (up to several days) in the villages to discuss issues with the farmers rather than just running through the list of questions in the survey.

Training of extension staff is proceeding in three key directions:

(1) The current generation of extension officers will be involved in the establishment of IDM demo plots and PAR trials. A training program, beginning in April 2006, has been developed for extension and other interested staff at CCI-Tavilo and SRS-Madang. Twelve extension officers and seven other staff including the CEO are participating at CCI-Tavilo and another 12 staff will participate in Madang. The approach is 'cocoa in the classroom' hand-on. The participants will be taught through the establishment of the demo plots and PAR trials in this project. Participants will learn by assisting the project team in activities including pruning and removing diseased pods as outlined in the management options schedule (this can be found in the November Workshop Manual). Participants will be assessed based on attendance, participation and improved understanding.

(2) Regional extension staff and model farmers will be trained through establishment of demo plots in selected villages. The trained farmers will share their knowledge with other farmers in their village in an 'apostle-disciple' style system. One farmer (apostle) will train 12 neighbouring farmers (disciples). An example of this was seen at Tinputz on Bougainville where Joseph Toumo (who attended the November workshop) has already implemented new management options in his cocoa block and has at least 12 farmers in his group who regularly come together and discuss their cocoa block management. The neighbouring farmers have introduced the new techniques into their own blocks, based on what Joseph has taught them. Sites have been selected around Madang, ENB, WNB and Bougainville for the establishment of demo plots and PAR trials. Farmers that will participate in the project as model farmers have also been identified.

(3) The future generation of extension officers will be trained through UniTech Lae and other universities.

Following the startup workshop in November several farmers have already implemented management options presented. Many of these farmers have opted for the higher management options. Early observations suggest that these farmers have a reduction in disease incidence. The next harvest will provide an indication of any effect on cocoa yield. Such results are also attracting the interest of farmers who were previously sceptical of the new management ideas.

Research and development pathological capabilities have been boosted through the relocation of Mr Yak Namaliu from Keravat to Madang to establish as cocoa research base at SRS Madang. Mr Namaliu is leading the Madang section of the project through the coordination and establishment of demo plots and PAR trials and extension of cocoa disease management. Keravat

ASEM/2004/011: Evaluating domestic tuna fisheries projects

Overseas Collaborating Countries	Papua New Guinea, Solomon Islands
Commissioned Organisation	University of Queensland, School of Economics, Australia
Project Leader	Professor Harry Campbell Phone: 07 3365 6570 Fax: 07 3365 7299 Email: h.campbell@economics.uq.edu.au
Collaborating Institutions	National Fisheries Authority, Papua New Guinea Forum Fisheries Agency, Solomon Islands
Project Budget	\$331,435
Project Duration	01/04/2005 to 31/03/2008
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Access fees paid to Papua New Guinea (PNG) from other distant water fishing nations grant these nations a right to fish in PNG's exclusive economic zone. Fees from the exploitation of these waters account for around 2 per cent of PNG Government revenue. Recently, however, domestic fishing interests have begun to exploit PNG's tuna fisheries as a basis for income, food security and employment. These fisheries are currently being fished at the maximum level of sustainability; increasing catches will create pressure on tuna stocks that may be unsustainable. If the tuna fisheries are to remain sustainable the line between domestic and distant water fishing fleets must be redrawn.

The National Fishery Authority is responsible for managing the tuna fisheries and their sustainability. But will domestic activities bring net benefits to the PNG economy as they slowly replace distant water fishing nations' access fees? The PNG Government has adopted a policy to support the gradual domestication of the tuna industry in the hope of generating a wider range of returns—building a framework, beginning with an existing model, in which to assess benefits from domestication is needed.

The project is supporting support this by increasing the capacity of NFA, and other agencies, to perform independent economic analysis of proposed domestic tuna fisheries projects. This will be achieved by:

- modifying an existing evaluation framework and applying the framework to measure the private and social net benefits of a locally-based tuna operation in PNG, and
- generalising the framework to be relevant for analysis of policy decisions regarding domestication of tuna and other industries.

Project progress

Year 1 (01/04/2005–31/03/2006)

A paper on the PNG labour force and employment conditions in Madang Province was prepared by the consultant, Dr Gumoi of UPNG, as background to the proposed labour force survey at RD Cannery, Madang. A meeting involving the PNG and Australian Project leaders, National Fisheries Authority (NFA) staff and Dr Gumoi was held at the National Fisheries Authority, Port Moresby on July 19 to discuss the project in general and the design of the labour force survey in particular.

The Australian project leader and project staff met with RD officials in Madang on July 20 2005. A further meeting to discuss progress was held at NFA on July 22. NFA staff led by Mr Ronald Kuk made a further trip to Madang to discuss the labour force survey with RD staff. The labour force survey was carried out between November 14 and December 7. A total of 207 employees (approximately 10% of the labour force) was interviewed by three interviewers, supervised by Dr Gumoi and Mr Jerome Tioti of NFA. The survey obtained information on the family circumstances, skills, employment opportunities and working conditions of male and female skilled and unskilled workers.

The results of the survey were entered in a spreadsheet file for analysis. The Australian project leader received additional details on the operations of RD Cannery, and preparation of a draft benefit-cost model commenced.

ASEM/2004/017: Assessment and improvement of quality management during postharvest processing and storage of coffee in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	University of New South Wales, Department of Food Science and Technology, Australia
Project Leader	Dr Robert Driscoll Phone: 02 93854355 Fax: 02 93855937 Email: r.driscoll@unsw.edu.au
Collaborating Institutions	PNG Coffee Industry Corporation, Papua New Guinea AT Projects, Papua New Guinea
Project Budget	\$760,812
Project Duration	01/01/2006 to 30/06/2009
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

The PNG coffee industry supports between 350 and 400 thousand families and earns K300 million per annum, but coffee quality has declined with the move to the low-input management of smallholder industry. Despite the general decline, premium PNG coffee retains a good reputation amongst customers and there is good scope to build demand for PNG coffee by improving marketing and quality. While farmer processing has the potential to improve returns by slowing quality deterioration and cutting transport costs, inadequate processing, drying or storage and the lack of consistency of product often reduces the product reliability and lowers prices. This project is working to improve coffee quality through assessment and improvement of postharvest systems for wet processing, drying and storing of smallholder production.

Project progress

First progress report due in 2007.

ASEM/2004/041: Productivity and marketing enhancement for peanut in Papua New Guinea and Australia

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Australia
Project Leader	Dr Rao C N Rachaputi Phone: 07 4160 0737 Fax: 07 4162 3238 Email: rao.rachaputi@dpi.qld.gov.au
Collaborating Institutions	Ramu Sugar Ltd, Papua New Guinea National Agricultural Research Institute, Papua New Guinea Trukai Industries, Papua New Guinea Department of Agriculture and Livestock, Papua New Guinea
Project Budget	\$844,422
Project Duration	01/01/2006 to 30/06/2009
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

As a part of the ACIAR project on 'Improving Yield and Economic Viability of Peanut Production in PNG and Australia; (ASEM 2001/55)', the critical role of peanuts in PNG farming systems was documented and high-yielding peanut germplasm lines from ICRISAT were introduced and evaluated in multi-location trials in PNG. These trials resulted in identification of promising varieties with potential to yield 50–100% greater than the local varieties. The next logical step is to transfer the new varietal and associated management technologies to smallholders and also to enhance the markets for, and marketability of, new peanut varieties in PNG.

The Australian peanut industry has highlighted a need to assess the potential for new markets for new peanut varieties and their products (i.e. especially high-oleic acid peanut oil which is comparable to sunflower oil). In Australia, spatial variability for yield and quality on broad acre farms is one of the major constraints to improving yield and profitability of commercial varieties. Recent work at DPI&F indicated that Near Infrared Reflectance (NIR) captured from aerial and satellite platforms can be effectively used to identify and monitor spatial variability (for disease, crop growth and maturity and aflatoxin risk) in peanut crops and to implement novel in-season management and harvesting strategies. NARI and Ramu Sugar are keen to apply this technology. In PNG, the application is more likely to be in terms of monitoring peanut crops (and other cropping systems), rather than intensive real time management, as is intended for Australia.

The objectives of the project are to:

1. ensure multiplication and supply of seeds of new high-yielding peanut varieties to smallholders in Morobe and Eastern Highland Provinces of PNG.
2. demonstrate and monitor improved productivity of peanut using varietal, management, modelling technologies and farmer-participatory research approach in PNG
3. develop and apply aerial NIR remote sensing technology to monitor spatial variability and improve productivity of peanut in Australia and investigate the scope for applying the NIR technology to monitor peanut cropping systems in PNG.
4. assess the potential of and feasibility to enhance marketability of new peanut varieties and products in PNG and Australia.

Project progress

First progress report due in 2007.

ASEM/2004/042: Assessing and extending schemes to enhance the profitability of the PNG coffee industry via price premiums for quality

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Curtin University of Technology, Agribusiness Marketing (Horticulture), Australia
Project Leader	Dr Peter Batt Phone: 08 9266 7596 Fax: 08 9266 4422 Email: p.batt@curtin.edu.au
Collaborating Institutions	PNG Coffee Industry Corporation, Papua New Guinea
Project Budget	\$391,572
Project Duration	01/04/2005 to 31/03/2007
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Coffee growers in PNG fall into two broad sectors—the estate comprising block-holders and plantations and the smallholder sector. Of the two, it is the smallholder sector that produces the majority of PNG's coffee. Smallholder farmers account for 85 per cent (56,100 tonnes) of production. The estate sector has been in decline for most of the past two decades, producing only 9900 tonnes.

The export of coffee is an important component of PNG's economy. Ten per cent of all PNG exports are from coffee, generating five per cent of GDP. Almost 400,000 rural households grow coffee and 20,000 people are employed in the processing and marketing areas. Despite this importance, PNG's reputation as a quality producer, which underpins export market access, is under question. The estate sector built this reputation for some of the world's leading quality coffee. However, the decline of the estate sector has corresponded to the decline in reputation that PNG coffee is now experiencing. As this reputation has dipped it has brought price premiums down with it.

Some smallholder producers are still commanding price premiums, through their involvement in several collaborative marketing arrangements. Producers are establishing long-term working relationships with suppliers paying premiums in return for quality coffee. This is a departure from current practices of paying a single price regardless of quality, guaranteeing a return to smallholders but in turn sacrificing overall quality. The alternative arrangements of groups of growers linked to processors suggest that tying price to quality can deliver quality when the working relationship provides sufficient market signals and information. Supply chain improvements also help, returning some of these benefits to smallholders.

Project objectives are to improve the economic returns to PNG smallholder coffee producers and the industry, through delivering a more consistent and higher quality product, by examining arrangements linking smallholders and processors.

Project progress

Year 1 (01/04/2005–31/03/2006)

During the first 12 months this project has: (1) undertaken a comprehensive analysis of the major constraints impacting upon the quality of coffee in PNG; (2) identified eight collaborative collection, pricing and processing schemes that provide superior quality coffee to customers and reward smallholder coffee producers; (3) commenced a survey of growers, traders, processors and exporters to identify the alternative routes to market and the reasons why coffee growers choose alternative routes; (4) conducted two introductory workshops to advise industry of the project and to foster improved relationships between coffee growers and exporters; and (5) delivered an introductory HACCP training course to the CIC.

In attempting to improve the quality of the coffee produced by smallholder coffee farmers in PNG, three key issues have repeatedly emerged: (1) poor road access; (2) lawlessness; and, (3) problems associated with land tenure and ownership (tribal conflict). While each of these impediments is beyond the scope of this project, at the individual farm level, the major problem for the smallholder coffee growers in PNG is the need for capital to meet anticipated household and farm expenses. As household expenses (including school fees) and social obligations receive first priority, there are often insufficient funds available to provide for the costs of labour to prune the coffee trees and to provide sufficient fertilisers and chemicals. As the coffee industry has a very poor financial reputation, the major banks are unwilling to extend credit.

Conflict remains between farmers and market intermediaries due to the farmers' lack of understanding as to how prices are determined in the international market. Few farmers appreciate the financial risks that traders and exporters endure in a highly volatile commodity market. A greater understanding of risk management and the costs associated with export should result in an improved relationship between smallholder coffee growers and their respective traders and exporters.

An analysis of marketing margins indicates that coffee growers in PNG receive between 68 and 80% of the gross FOB price (Lae) for green bean. However, such margins are available only to those growers who are within close proximity to the traders and processors. For those growers located in more remote areas, transport costs will be appreciably higher and may consume most of the margin. Nevertheless, this figure indicates that the processing/exporting sector is relatively efficient and that growers are receiving reasonable prices as a percentage of the FOB price.

It is evident, that parchment is purchased at a significant discount to cherry, reflecting the lack of control and the variability that is inherent in smallholder parchment. Where farmers are sufficiently close to a wet mill so that they can deliver the cherry to the mill on the same day of harvest, or where the mill itself arranges transport to collect the cherry, farmers are being actively encouraged to sell cherry rather than to produce parchment. By having control of the process from pulping, fermenting, washing and drying, processors are able to produce a finished product with very similar characteristics to plantation style coffees. As exporters are able to deliver a more consistent quality product to the market, not only is the discount on the New York Board of Exchange Coffee Futures Contract (NYC) reduced, but opportunities emerge for PNG coffee to enter the speciality market.

Expansion into the speciality coffee market has been encouraged by the recent arrival of Starbucks into PNG. In part, this has been responsible for the dramatic increase in the proportion of smallholder coffee sold as cherry for those growers who are close enough to a processing mill. Starbucks arrival in the market is also providing the major catalyst for the development of fully inclusive quality assurance programs that provide guidelines not only on the physical and cup quality characteristics, but also propose environmental, social welfare and equity conditions that preferred suppliers must meet. With Starbucks providing the price incentives, these developments align themselves very well with the project objectives, especially in promoting the need for quality at the farm level.

For those smallholders unable to access a wet factory, selling cherry is not an option. In such instances, farmers must produce parchment. Because of the small volume of parchment each individual farmer produces, smallholder farmers are unlikely to benefit from any improvement in quality without achieving a parallel increase in scale. This is best achieved through the formation of collaborative farmer groups, where the members, either collectively or individually, follow a strict quality assurance system that reduces the variation in quality. The formation of these collaborative farmer groups is seen to offer benefit even to those smallholder farmers and blockholders who sell cherry to processors. It is more cost-effective to utilise such groups for the delivery of extension and training programs. However, the formation and on-going management of these collaborative groups is not without problems. Of particular importance is the issue of leadership to ensure that group members are not only fully informed, but that, in the event of the leader's demise, the group has the capacity to continue.

ASEM/2004/077: Postgraduate scholarship scheme for UNITECH, University of Lae, Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	University of Queensland, School of Land and Food, Australia
Project Leader	Dr Barry W Norton Phone: 07 3289 0260 Fax: 07 3289 0103 Email: b.norton@uq.edu.au
Collaborating Institutions	University of Technology, Head, Department of Agriculture, Papua New Guinea
Project Budget	\$600,605
Project Duration	01/01/2005 to 30/06/2008
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

In response to new initiatives by University of Technology (Unitech), Lae, to introduce a program of postgraduate training in 2005, ACIAR is funding a scholarship program to support students during their training. Initially in 2005 funding is available for six students (stipend plus all costs associated with project administration and research support).

It is anticipated that this program will run for three years, training in total nine candidates to postgraduate diploma level and six as MPhil graduates. Unitech staff are supervising these projects with planning assistance from senior UQ staff, and are being encouraged to seek research linkages with existing ACIAR, NARI and industry projects. Progress is being reviewed each year, and continuation recommended when each year-group of students graduates in the prescribed time.

Project progress

Year 1 (01/01/2005–31/12/2005)

The ACIAR Scholarship Scheme was initiated in the Department of Agriculture at Unitech at the beginning of the first semester in March 2005 when six scholars were appointed to undertake postgraduate studies—five (Dateona, Tumaë, Sil, Kombukon, Kawa) for Postgraduate Diploma (PGD) and one (Ms Rova) for Master of Philosophy (MPhil). All undertook prescribed courses as well as planning and conducting their respective small research project. The results from the PGD projects were submitted in thesis form for examination in November 2005 or, where judged appropriate, this research could be continued for a further year, and the results submitted for MPhil. Two scholars were upgraded to MPhil (Tumaë, Dateona) and three (Sil, Kawa, Kombukon) submitted and passed all requirements for PGD, graduating officially in April 2006.

The topics of research included studies of the economics of peanut production, fish nutrition, fresh produce storage systems, yield decline in sweet potato, viral diseases of Taro and studies of host resistance to the sugar cane borer. It is expected that the three remaining MPhil students will complete by the end of 2006 and graduate in early 2007.

In the process of providing support for these scholars, a PG computer laboratory (six computers plus ancillary equipment) was established and research funds supplied which permitted some upgrading of existing research facilities in the Department. In November 2005 a further seven scholars (one woman) were appointed to undertake initially PGD training in 2006. These scholars were selected from a total of 12 qualified applicants and started their programs in March 2006. Again a wide range of topics has been chosen for study, and includes nine of the 14 staff in the Department as supervisors.

The topics for 2006 include extension studies with peanut farmers, the incidence of leptospirosis in local cattle, developing sources of traditional feed for pigs and fish (tilapia), genotype x environment interactions in taro, studies of vesicular streak disease of cocoa and virus detection in sweet potatoes. New computers and upgraded laboratory and greenhouse facilities are planned for 2006, with possible support from the current project for some of the costs. The budget for 2005–06 was sufficient to meet requirements, and a small surplus will be carried forward to 2006.

CP/1994/043: Virus indexing and DNA fingerprinting for the international movement and conservation of taro germplasm

Overseas Collaborating Countries	Fiji, Papua New Guinea, Samoa
Commissioned Organisation	Queensland University of Technology, Centre of Molecular Biotechnology, Australia
Project Leader	Associate Professor Rob Harding Phone: 07 3864 1379 Fax: 07 3864 1534 Email: r.harding@qut.edu.au
Collaborating Institutions	Secretariat of the Pacific Community, Fiji Ministry of Agriculture, Forests, Fisheries and Meteorology, Samoa University of Queensland, Australia University of Technology, Papua New Guinea University of the South Pacific, Samoa National Agricultural Research Institute, Papua New Guinea
Project Budget	\$1,576,307
Project Duration	01/07/1998 to 30/06/2007 (Project extended from 01/07/2001 to 30/06/2007)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Taro is widely grown in Papua New Guinea (PNG) and many other Pacific Island countries. It also plays an important cultural role. The roots are a source of carbohydrate, and the foliage is also eaten. It is cultivated mainly in gardens for local use, but there is also a domestic and export market. Over the last 20 years there has been a gradual decline in the production of taro because of the effects of pests and diseases. Taro leaf blight, caused by a fungus, is the most serious and widespread disease of the plant in Pacific countries. It has long been present in Micronesia, Papua New Guinea and the Solomon Islands, but in 1993 it spread to American Samoa and Samoa with devastating consequences. Many growers have since abandoned taro cultivation in these countries, causing major social and economic problems. Export earnings in Samoa fell from 9.5 million Tala to 158,000 Tala in just one year after the arrival of the blight.

The genetic diversity of taro is poorly known, but some described varieties are resistant to the fungus. In 1993, a breeding program started up in PNG to develop these varieties but the taro germplasm cannot be moved between countries because of the presence of a lethal virus disease known as alomae. It is now important to characterise this disease (which seems to be associated with the presence of two viruses together) and develop reliable tests for the presence of both viruses within taro germplasm. This should then allow free movement of germplasm and thereby help in combating leaf blight and in developing other features of the plant.

Increased knowledge of alomae will be helpful of itself because this disease is now the main constraint on taro production in PNG and the Solomons. Elsewhere it seems that the two viruses do not occur together; when only one virus is present, disease symptoms are much milder. Characterising the virus diseases of taro, a Pacific Island staple crop, is underway as the first step to developing sensitive specific tests for each virus.

The aim of the project is to characterise the virus diseases of taro, a Pacific Island staple crop, and to develop sensitive specific tests for each virus.

Project progress

Year 8 (01/07/2005–30/06/2006)

Improved knowledge of virus epidemiology:

The majority of information dissemination activities are being deferred until the end of the project when more information has been obtained. Discussions and planning for these activities are currently in progress.

Known healthy, but disease-susceptible taro plants are being multiplied in tissue culture for use in transmission experiments. Potential virus vectors are being collected and placed on these healthy plants which are then being examined for virus symptoms.

Known TaVCoV-infected taro lines are being multiplied in order to have sufficient numbers to conduct transmission experiments with Tarophagus.

Potential vectors of alomae disease and known virus-infected plants are being multiplied to enable tests to determine the etiology (causes, origins, evolution, and implications) of alomae disease.

Safe distribution of taro germplasm:

This objective relies on the use of PCR-based virus diagnostics at Unitech. New primers and other reagents have been sent to Unitech from QUT. Despite initial difficulties with the diagnostics, it now appears that the problems have largely been overcome. Once the technique has been proven reliable, germplasm can be tested for viruses prior to release.

CP/1996/091: Biological control of *Chromolaena odorata* in Indonesia, Papua New Guinea and the Philippines

Overseas Collaborating Countries	Indonesia, Papua New Guinea, Philippines
Commissioned Organisation	Queensland Department of Natural Resources and Mines, Australia
Project Leader	Dr Michael Day Phone: 07 3375 0725 Fax: 07 3379 6815 Email: Michael.Day@nrm.qld.gov.au
Collaborating Institutions	Universitas Nusa Cendana, Indonesia SEAMEO Regional Centre for Tropical Biology, Indonesia National Agricultural Research Institute, Papua New Guinea Parks and Wildlife Commission of the Northern Territory, Australia Gadjah Mada University, Indonesia Philippine Coconut Authority, Philippines Indonesian Oil Palm Research Institute, Indonesia Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement, Indonesia Oil Palm Research Association, Papua New Guinea
Project Budget	\$1,055,012
Project Duration	01/07/1997 to 30/09/2006 (Project extended from 01/01/2002 to 30/09/2006)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Siam weed is a serious weed of tropical pastures and a threat to national parks and other biodiversity conservation areas. It is a prolific seed-producer and is usually toxic to livestock. It has quickly spread from its original home in the West Indies to large areas of the wet tropics of Africa and Asia. It reached Timor by the mid-1970s and is now present in parts of Irian Jaya, New Britain and possibly Solomon Islands. Siam weed is now considered the major weed threat to Australia. An infestation was discovered in Tully, Queensland, in 1994 and is now being eradicated with herbicides.

There are many natural enemies of this weed and biological control has long been touted as an option. By 1992, only two agents had been tried—a seed-eating weevil (*Apion brunneonigrum*) and a leaf-eating moth (*Pareuchaetes pseudoinsulata*), which were both tried in South Africa.

ACIAR project CS2/91/10 released the moth into oil palm and pastoral areas in Java, Sumatra and Timor. The moth successfully established in several areas in Sumatra, where there is now effective control of the weed. However, the agent did not persist in Java or Timor.

Project CS2/91/10 also introduced a new control agent, the stem-galling fly *Procecidochares connexa*, from South America, which had not been tried or host-tested anywhere else in the world. The first releases were made in Indonesia in July 1995; it was also intended for release in the Philippines but government permission was not granted during the lifetime of the project. However, permission came through in February 1997, so this agent will be released in the current project.

The aim of this project is to enhance the biological control of Siam weed (*Chromolaena odorata*) in Indonesia, Papua New Guinea and the Philippines. The work continues that begun in a previous ACIAR project (CS2/91/10), which released control agents in Indonesia. The current project intends to carry out further releases, conduct field monitoring of their effectiveness and introduce additional control agents.

Project progress

Year 7 (01/01/2005–31/12/2005)

In the previous project (1993–97) Indonesia approved the field release of the gall fly *Cecidochares connexa*. In this project the Indonesian government further approved the field release of the butterfly *Actinote anteus*. By this approval the Indonesian authorities showed that they accepted the release of a new agent not been previously released anywhere in the world, **based solely on tests undertaken by their own organisations.**

Value of research and principal beneficiaries

The value of this research is three-fold:

- the achievement of safe, sustainable control of this major weed in Indonesia and PNG, and the prospect of this for the Philippines.
- training for scientists in Southeast Asia in biocontrol as a method.
- reduction in the risk of spread to northern Australia.
- a proven biocontrol method for use in other countries with this weed, and in Australia if chromolaena does become established.

The beneficiaries are thus:

- plantations, forestry, small farmers, and cattle husbandry in Indonesia, PNG, and the Philippines. Weed control is one of the major costs of slash-and-burn husbandry, and is economically impossible for cattle production. Chromolaena has caused total abandonment of whole villages dependent on cattle and small-scale crops in areas with a severe dry season. The progressive control achieved through this research will enable the livestock industry in these areas to survive.
- the scientists involved directly, and indirectly the whole of South East Asia. Biocontrol is an environmentally benign and economically sustainable weed control method, which is under-utilised because of lack of knowledge and experience.
- all of northern Australia, through reduced surveillance costs, and reduced costs and environmental damage if/ when the weed becomes established in northern Australia.
- other countries with this weed problem (India, West Africa, Pacific countries) who can import the gall fly for minimal cost.

CP/2000/044: Taro beetle management in PNG and Fiji

Overseas Collaborating Countries	Fiji, Papua New Guinea
Commissioned Organisation	Secretariat of the Pacific Community, Fiji
Project Leader	Mr Aleki Sisifa Phone: 679 3379214 or 679 3370733 ext. 214 Fax: 679 3370021 Email: Alekis@spc.int
Collaborating Institutions	CSIRO Entomology, Australia Ministry of Agriculture, Sugar and Land Resettlement, Fiji National Agricultural Research Institute, Papua New Guinea
Project Budget	\$853,855
Project Duration	01/01/2002 to 31/12/2007 (Project extended from 01/01/2006 to 31/12/2007)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Taro is the preferred staple in Pacific communities. One of the main pests of taro is the taro beetle, which damages the corm (an underground stem resembling a bulb) of the plant and creates entry points for secondary pests. The taro beetle causes about 30 per cent yield loss in taro-producing countries such as PNG and Fiji. Taro production is a labour-intensive crop which is grown on a small scale in farming communities. The spread of the taro beetle in the Pacific is a threat to taro exporters and their revenue, and it also has an environmental impact because infested taro gardens are abandoned and lead to clearing of established forests for new gardens.

For Australia, the use of fungi such as *Metarhizium* is attractive because fungi are specific, natural and often give persistent control in the soil. However, the use of mycoinsecticides in Australia has been slow because of the lack of suitable products and the high costs. To improve this situation more research is needed to improve the understanding of strain selection, mass production, formulation and application strategies.

This project is developing biological controls for the taro beetle, including investigating the combined action of pesticide control and bio-control. It will implement these methods for taro beetle management in environmentally sustainable cropping systems in Papua New Guinea (PNG) and Fiji. These practices will reduce taro beetle damage in farmers' fields, restore the supplies of taro as a major staple and revive the trade in quality taro in infested countries. This project relies upon bio-control methods that were identified during a previous project: the fungus *Metarhizium anisopliae* (Ma), and the virus *Baculovirus oryctes* (OrV).

Project progress

Year 4 (01/01/2005–31/12/2005)

The Taro Beetle Management program commenced on 1 January 2002 (actual date of start about June 2002) for duration of 4 years as a component of SPC Pest Management in the Pacific (PMP) program. PMP, one of the two major projects of SPC-Plant Protection Service, is funded jointly by Australia (AusAID and ACIAR) and New Zealand (NZAID). The other project is Plant Protection in the Pacific (PPP), funded by European Union (EU). PPP commenced on 1 January 2002 for 4 years. Additional taro beetle activities outside PNG and Fiji are funded by EU-PPP'

2005 was the final year of the 4-year project. All activities as planned were carried out smoothly. The project end review took place in June and came up with recommendations as follows.

Recommendation 1. This project should continue into a second phase, centred on participatory adaptive research with the objective of integrating the results of the applied research of Phase 1 into sustainable farming systems management practices. Progress should be monitored by impact assessments at the start and end of this phase.

Note: it is suggested that the private sector is integrated into a planning process at an early stage (to share ownership) so that the supply of materials to retail outlets is not a limiting factor and to arouse interest in the commercial production of *Ma*.

Recommendation 2. Whilst insecticides from two groups have proved effective, it is suggested that provision is made in a second phase to permit screening of materials from other groups of insecticides (e.g. organophosphate and carbamate) to ensure that an effective resistance management/prevention program can be formulated.

The current project has indicated that there are two areas of basic research that will, if successful, enhance the outcome of a second phase. Many scarabaeidae beetles emit potent sex attractant pheromones. They can be applied for monitoring, and lure and kill operations. The latter is of relevance to the needs of atoll and small island communities because they will make it possible to reduce beetle populations without risking the contamination of groundwater as result of applying insecticides to the soil.

Recommendation 3. ACIAR should support a program to identify the sex attractant pheromone in male (possibly, re *Scapanes australis*) or female beetles and to include the application of this technology as a component of the second phase of the project. This could be considered initially as a separate sub-component, supported in advance of other work.

'Taro beetle' is a complex of two genera and probably more than 10 species. The main species are identifiable by conventional methods, but are extensive in distribution through an unknown number of island habitats. It is possible that isolation has resulted in intraspecific variation. Response to interventions is known to differ between species. There is concern that assumptions about the transferability of technology, especially those concerning *Ma*, may not be valid because of a mismatch between host and disease. DNA analysis technology is available and relatively inexpensive compared to the cost of initiating abortive control programs on offshore islands. This technique can be based on DNA from museum specimens and/or newly collected material.

Recommendation 4. The project extension includes a component in which speciation and intraspecific separation among taro beetle genera is examined by DNA analysis (fingerprinting). It is anticipated that the project will generate technology suitable for uptake by extension programmes in a relatively short time, so that the project should engage with development agencies well before a phase 2 is complete. (NB AusAID supports the Agricultural Innovation Grant Facility in PNG, and IFAD is a suitable agency to be approached to support a development program in the Pacific community.)

Recommendation 5. Project managers are to initiate the step up process during a second phase.

Recommendation 6. Whilst some extension material has been prepared for farmers it is suggested that the approach and media adopted for technology transfer is considered carefully and that consideration should be given to an engaging a specialist agency for this purpose.

Recommendation 7. In the proposed phase 2, time should be allocated for the preparation of formal publications of the science in professional journals.

The technical progress in 2004 was reviewed at the 5th Taro Beetle Management Technical Coordinators Meeting in November in Fiji.

2005 progress was as follows:

PNG:

12 major activities

- 6 on station field trials
- 6 on-farm trials

2 supporting activities

- Laboratory trials:
- Ma fungus low tech production
- Ma fungus bio-assay with Ma x confidor in synergy

Outcomes

- Ma fungus can be produced, maintained and mass reared in PNG
- Ma alone is not an effective control measure against taro beetle damage
- Ma x confidor (1 ml/L) gives very good control of beetles in both lab and field situation.
- Artificial breeding sites were successful in attracting the beetles to breed and rotten saw dust and cow dung and sawdust were the best attractants.
- Artificial breeding sites + Ma & confidor in synergy may have a strategic use in atoll situation.
- Advanced field experiments on confidor and Bifenthrin insecticides revealed the following:
 - Confidor and Bifenthrin applied twice gave excellent beetle control and export taro quality and quantity
 - Bifenthrin double application has no detectable residues in taro corm
 - Confidor has trace in taro corm in high dose (7mls/L) applied twice which is double the optimum dose (3mls/L) for confidor currently in evaluation.
- Farmer surveys confirmed taro beetle is the most serious constraint to taro production followed by soil fertility and disease (leaf blight and pithium).
- On-farm outreach liaison work/trials confirmed keen interest shown by farmers to adopt the new innovation or package.

FJI:

9 major activities

- 1 Ma/confidor synergy trial
- 1 advanced confidor rate and frequency evaluation trial
- 7 confidor multi-location trials

2 supporting trials

- Ma bio-assay—Ma rates vs mortality
- Residue analysis potted taro plants treated with confidor at different rates (1, 3, 5 & 7 mls/L) applied once vs twice.

Outcomes—repeat of trials in Fiji has also shown that Ma on its own cannot control the taro beetle. Insecticides Imidacloprid and Bifenthrin gave very good control of the beetle.

CP/2002/013: Biology, damage levels and control of red-banded mango caterpillar in Papua New Guinea and Australia

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Centre for Tropical Agriculture, Australia
Project Leader	Dr Bruno Pinese Phone: 07 40484666, 07 40484600 Fax: 07 40923593 Email: bruno.pinese@dpi.qld.gov.au http://www.dpi.qld.gov.au
Project Web Site	
Collaborating Institutions	Department of Agriculture, Fisheries and Forestry, Australia National Agricultural Research Institute, Papua New Guinea National Agriculture Quarantine and Inspection Authority, Papua New Guinea
Project Budget	\$357,291
Project Duration	01/07/2003 to 30/06/2007 (Project extended from 01/07/2006 to 30/06/2007)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

The red banded mango caterpillar (RBMC) is widespread throughout Southeast Asia, although its abundance in many areas is very low. Papua New Guinea has RBMC present, as do a few islands in the Torres Strait, separating PNG from Australia. Mainland Australia was free of the caterpillar until recently, when small numbers were detected in feral mango trees on the tip of the Cape York Peninsula. Little is known about the biology of the RBMC, despite the significant losses it can cause. In Indonesia and PNG losses of between 30 and 40 per cent of mangoes on infected trees are common, with losses as high as 80 per cent in some places. Pest management is dependent on knowledge of the lifecycle, strengths, weaknesses and behaviour patterns, as well as natural enemies of the RBMC. Management to eradicate pests without this knowledge may result in adverse consequences for other insects, fruit quality and productivity.

The caterpillars feed on mangoes at all stages of fruit development, with successive generations burrowing closer to the seed. Improved knowledge of this lifecycle will help determine potential controls, both to eradicate and prevent pest losses. The project is studying the biology of the RBMC as a means of identifying methods to better manage the pest.

Project progress

Year 3 (01/07/2005–30/06/2006)

Project activities during 2005–06 concentrated on the pheromone identification, development of an effective synthetic blend and field evaluations. Alternative host feeding tests, biology studies and pesticide field trials were also conducted in East New Britain and Port Moresby.

Pheromone identification was carried out in New Zealand by HortResearch using pupae of the RBMC (*Deanolis sublimbalis*) reared in Papua New Guinea. Analysis by gas chromatography and mass spectrometry of female pheromone glands identified two major components, (11Z)-hexadecenal (Z11-16:Ald) and (3Z,6Z,9Z)-tricosatriene (3Z,6Z,9Z-23:Hy) as being necessary for male moth attraction. In field trials, delta traps baited with 1 mg of a 1:1 mix of Z11-16 Ald and 3Z,6Z,9Z-23Hy provided good catches of moths and this blend will be used in subsequent ecological studies in PNG and in quarantine monitoring for RBMC in northern Australia.

Results from alternative host testing conducted at Keravat, East New Britain, showed that a range of fruit with large kernels including Tahitian chestnut, candle nut, Bukbuk nut, Pau nut and avocado will not support the development of larvae. These results support other studies and it appears very likely that the red banded mango caterpillar is a monophagous species.

Chemical control trials in PNG provided confirmation of results obtained in the previous season with only thiacloprid (Calypso) reducing the incidence of fruit damage. Once again the use of other less effective broad spectrum insecticides increased the level of damage when compared with untreated trees and the removal of weaver ants by these insecticides has been implicated. New work is planned to quantify the impact of weaver ants as potential biocontrol agents. If effective, promoting the build-up of weaver ants on mango trees is seen as a practical and affordable method of biocontrol of red banded mango caterpillar in Papua New Guinea.

CP/2003/029: Management of potato late blight in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Department of Primary Industries, Victoria, Knoxfield Centre, Australia
Project Leader	Rudolf De Boer Phone: 03 9210 9222, mobile 0408 592 051 Fax: 03 9800 3521 Email: dolf.deboer@dpi.vic.gov.au
Collaborating Institutions	CRC for Tropical Plant Protection, Australia International Potato Center, Peru National Agricultural Research Institute, Papua New Guinea Fresh Produce Development Company Ltd, Papua New Guinea Papua New Guinea Cocoa and Coconut Institute, Papua New Guinea
Project Budget	\$918,109
Project Duration	01/11/2004 to 31/10/2009
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Potatoes are an important cash crop in Highland provinces. Commercial trade had reached 15,000 tonnes annually with a total value of K10–15 million. This trade involved smallholders, many of who also rely on potato as a food staple and income source. Barter trade in potatoes is also widespread. An outbreak of potato late blight in early 2003 began destroying potato crops throughout the Highlands region. The cause is believed to be a virulent and new strain or strains of *Phytophthora infestans*, found in other potato growing regions throughout the world but not in PNG prior to the outbreak.

The highlands climate is ideal for late blight, making control regimes vital, and also expensive. Fungicide spraying is needed every 3–5 days during potato cropping but the chemicals and equipment are beyond the purchasing power of most smallholders. Ensuring potatoes remain a viable crop for smallholders will depend on finding new seed stock that is resistant to blight and or effective and inexpensive control regimes.

The project is working towards these aims, specifically by:

- introducing, multiplying, evaluating and deploying late-blight-resistant potato clonal material into Papua New Guinea, and
- developing safe and cost-effective integrated late blight management strategies for existing and new potato cultivars

Project progress

Year 1 (01/11/2004–31/10/2005)

This program builds on research and extension activities started in an AusAID ACNRS project *Management of potato late blight in PNG* (2004). The objectives of the current project are to introduce, multiply, evaluate and deploy late blight resistant clonal material into PNG and to develop safe, cost effective integrated late blight management strategies for existing and new potato cultivars and ultimately to rehabilitate potato production for smallholders.

Thirty-six International Potato Centre (CIP) potato clones, introduced into PNG in 2003, were resurrected from tissue culture in Keravat and propagated to seed tubers in National Agricultural Research Institute (NARI) facilities in Aiyura and Tambul. In field trials without fungicide sprays, 12 of these clones survived late blight disease several weeks longer than more susceptible clones, which died before reaching maturity. Four of 12 cultivars from Australia that were screened in three field trials proved to be significantly less susceptible than the standard Sequoia and will be further evaluated in under a fungicide spray regime.

Ten 'best bet' late blight resistant CIP potato clones were propagated as minitubers by Lima, Peru and will be shipped to PNG in December/January to boost seed supplies for trials. Tissue culture plantlets of the 10 clones will also be sent to PNG from Peru to refresh current stocks, as well as to Australia as back-up tissue culture stocks.

Lack of seed potatoes is a critical factor preventing farmers from participating in potato production. A potato production specialist, Corina Horstra from Department of Primary Industries Victoria, reviewed propagation and multiplication capability in PNG during a visit to the tissue culture and seed tuber production facilities at Aiyura and Tambul, respectively, in June 2005. It was concluded that both NARI (tissue culture production) and Fresh Produce Development Agency (seed potato production) have the technical capability to produce high quality seed potatoes for PNG. A number of technical problems at the tissue culture facility at Aiyura, which were identified as hampering the consistent supply of tissue culture plantlets to stock the FPDA screen houses in Tambul, are being rectified. FPDA has built additional screen houses at Tambul to increase their minituber production capability for the seed program.

Availability of fungicides in PNG is limited to copper and chlorothalonil based products. Preliminary fungicide evaluation trials had demonstrated that weekly sprays with copper based products provided sufficient control of late blight to allow the susceptible cultivar Sequoia to be grown to maturity. In further trials, weekly sprays of chlorothalonil proved to be superior to copper sprays in protecting plants from late blight. However, chlorothalonil is significantly more expensive than copper and the challenge is to determine whether the integration of the two fungicides can provide sufficient protection of Sequoia crop but at a reduced cost.

FPDA, with input from NARI, have been successful in laying the foundation for rebuilding PNG potato industry through the delivery of supplies of quality seed and through village extension worker training activities which have involved 2500 smallholders. However, at present potato production in PNG is generally limited to a relatively small number of 'commercial' growers who have access to land, backpack sprayers, chemicals, seed potatoes and labour and based on the highly susceptible cultivar Sequoia.

CP/2003/042: Fruit fly management in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	NSW Department of Primary Industries, Australia
Project Leader	Mr Andrew Jessup Phone: 02 4348 1965 Fax: 02 4348 1910 Email: andrew.jessup@dpi.nsw.gov.au
Collaborating Institutions	National Agriculture Quarantine and Inspection Authority, Papua New Guinea National Agricultural Research Institute, Papua New Guinea University of Western Sydney, Australia Queensland University of Technology, Australia Pacific Adventist University, Papua New Guinea Fresh Produce Development Agency, Papua New Guinea
Project Budget	\$742,004
Project Duration	01/04/2006 to 31/03/2009
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Horticulture crops are a potential cash source for smallholders throughout Papua New Guinea, often being grown on small, mixed-cropping farms. Fruit flies cause substantial losses for banana, papaya, mango, tomato, capsicum and cucurbits. The flies lay eggs in fruit, which then infest the fruit rendering it inedible. Estimates put infestation levels in PNG routinely above 20 per cent. Two species of fruit fly, *Bactrocera frauenfeldi* and *B. musae*, are the leading pests and have been the subject of past research, which will be synthesised, tested, expanded upon where needed and then disseminated to farmers through this research.

Project progress

First progress report due in 2007.

CP/2004/001: TaroPest: A computer-based information and diagnostics package for taro pests of the South Pacific

Overseas Collaborating Countries	Fiji, Papua New Guinea
Commissioned Organisation	Queensland University of Technology, School of Natural Resource Sciences, Australia
Project Leader	Dr Anthony Clarke Phone: 07 3864 5023 Fax: 07 3864 1535 Email: a.clarke@qut.edu.au
Collaborating Institutions	Secretariat of the Pacific Community, Fiji National Agriculture Quarantine and Inspection Authority, Papua New Guinea
Project Budget	\$368,533
Project Duration	01/07/2004 to 30/06/2007 (Project extended from 01/01/2007 to 30/06/2007)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Taro is culturally and economically important in the South Pacific. Culturally it is a staple food, important to food security and as a 'prestige' crop with a role in gift giving and ceremonial activities. Economically it generates substantial returns (in Fiji FJD\$1.85 billion) and creates flow on benefits such as employment and income in rural areas. Taro is also important as an export industry in some Pacific Island countries. Where exporting occurs facilities for packing and shipping can provide jobs, a valuable avenue out of poverty. The main barriers to productivity are pests and diseases. More than 130 pests and diseases have been recorded in the SPC Plant Protection Service database. Many of these cause minor crop losses, but a few can devastate crops, such as leaf blight in Samoa in 1993 which virtually eliminated taro. The majority of pests and diseases are present in only a few countries. This makes the introduction of these to other countries, as in the case of Samoa above, all the more devastating.

The exporting and trade of taro increases the risks of diseases and pests spreading. Quarantine agencies in the region have an important role to play in ensuring this spread is stopped. Diagnostic expertise for quarantine officers, extension workers, farmers and some scientists is lacking. A comprehensive package is needed to help the range of people involved in taro farming, trade and research better manage pest and disease diagnosis. The project is:

- producing a diagnostic and information package for taro pests and diseases of the South Pacific,
- enhancing regional capacity in the ability to build and use Lucid based software information and diagnostic packages, and
- testing and incorporating user feed-back and dissemination of *TaroPest* to end-users.

Project progress

Year 2 (01/07/2005–30/06/2006)

The project is progressing well towards the listed goals and outcomes. A beta version of the website is currently online and publicly accessible (<http://taropest.sci.qut.edu.au>). Image collection and completion of the remaining fact sheets is continuing.

Objective 1: The TaroPest website has been publicly accessible since April 2006. Significant effort (announcements on list-servers, articles in international IPM groups, personal emails, hard-copy letters and meeting presentations) has gone into publicising TaroPest and inviting testing and feedback. Hardcopy extension material is currently being developed to provide a print on demand resource. The key and associated fact-sheets and other supporting documentation, the primary objective of this project, are well advanced

Objective 2: Training has been continuing on a virtual basis with regular email contact. No formal training has been carried out in the reporting period.

Objective 3: Since early April 2006, TaroPest has been publicly accessible. We have invited end-users to test and provide feedback on the website and are actively modifying TaroPest in response to feedback on an ongoing basis.

TaroPest is able to be located through Google, which has significantly increased visitors to the site. TaroPest is advertised on the Lucidcentral.org website, and has been the focus of articles in the Taro Growers Association of Australia newsletters, SPC Land Resources Division newsletters, and the Papgren (Plant Genetic Resources News from the Pacific) Forum.

CP/2004/064: Biological control of 'mile-a-minute' (*Mikania micrantha*) in Papua New Guinea and Fiji

Overseas Collaborating Countries	Fiji, Papua New Guinea
Commissioned Organisation	Queensland Department of Natural Resources and Mines, Alan Fletcher Research Station, Australia
Project Leader	Dr Michael Day Phone: 07 3375 0725 Fax: 07 3379 6815 Email: michael.day@nrm.qld.gov.au
Collaborating Institutions	Secretariat of the Pacific Community, Fiji Ministry of Agriculture, Sugar and Land Resettlement, Fiji National Agricultural Research Institute, Papua New Guinea Oil Palm Research Association, Papua New Guinea Papua New Guinea Cocoa and Coconut Institute, Papua New Guinea
Project Budget	\$579,018
Project Duration	01/01/2006 to 31/12/2008
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Food production, both of estate crops (sugarcane, vanilla, cocoa, coconuts, banana, coffee, kava and palm oil) and in food gardens (taro, papaya and green vegetables) is important for smallholder incomes. This is particularly the case in Papua New Guinea, Fiji and Samoa. Two species of weeds, 'mile-a-minute' and 'giant sensitive plant' threaten these enterprises. Both are invasive weeds, widespread through each country, and capable of smothering food crops. Yields can be significantly reduced, affecting food security. Manual and chemical controls are too expensive for most farmers. Biological control, established through the identification and release of natural weed predators is being evaluated, based on known agents trialled or in use elsewhere.

Project progress

First progress report due in 2007.

CP/2004/071: Reducing pest and disease impact on yield in selected PNG sweet potato production systems

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Australia
Project Leader	Mr Eric Coleman Phone: 07 49360234 Fax: 07 49361484 Email: eric.coleman@dpi.qld.gov.au
Collaborating Institutions	Queensland University of Technology, Australia National Agricultural Research Institute, Papua New Guinea National Agriculture Quarantine and Inspection Authority, Papua New Guinea Fresh Produce Development Agency, Papua New Guinea International Potato Center, Peru
Project Budget	\$905,775
Project Duration	01/04/2006 to 31/03/2010
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Sweet potato is the most important food staple in Papua New Guinea, accounting for 60 per cent of dietary calories. Mainly grown by subsistence farmers, excess production can also be sold or marketed for cash. Despite this importance yields have been declining for some time, due to the combination of pests, diseases and physiological factors. An Integrated Pest Management (IPM) scheme would aid in reducing pest and disease losses. A pathogen-tested (PT) scheme for planting material will be incorporated into the IPM scheme. Linking both should ensure that the impacts of pests and diseases are reduced, particularly with farmers participating in technology development to support the scheme.

Project progress

First progress report due in 2007.

CP/2006/017: Management of *Eumetopina flavipes*: the vector of ramu stunt disease of sugarcane in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Bureau of Sugar Experiment Stations, Australia
Project Leader	Dr Robert Magarey Phone: 07 4068 1488 Fax: 07 4068 1907 Email: rmagarey@bses.org.au
Collaborating Institutions	James Cook University, Australia Ramu Sugar Limited, Papua New Guinea
Project Budget	\$149,641
Project Duration	01/06/2006 to 31/05/2008
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Eumetopina flavipes, a planthopper, is the vector of the devastating sugarcane disease 'Ramu stunt', which has been responsible for production losses of up to 60% at Ramu Sugar Ltd in Papua New Guinea (PNG) in some years. *Eumetopina* is established on mainland Australia and on many Torres Strait Islands (TSI), and is widespread throughout PNG. It is currently a high priority on both state and federal Australian quarantine target lists. In this joint project involving BSES Ltd, James Cook University (JCU) and Ramu Sugar, the main aims are to develop an integrated management program for *E. flavipes* and to enhance the protection of Australian sugarcane should an incursion of *E. flavipes* occur and eradication or control options be required. This work complements the existing studies under ACIAR Project CP/1996/140, which involve the development of an assay to detect the causative agent of Ramu stunt, as well as research into agent transmission by *E. flavipes*.

Project progress

First progress report due in 2007.

FIS/2001/075: Sustainable aquaculture development in Pacific Islands region and northern Australia

Overseas Collaborating Countries	Fiji, Kiribati, Papua New Guinea, Samoa, Solomon Islands, South Pacific general, Tonga, Vanuatu
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Agency for Food and Fibre Sciences - Fisheries and Aquaculture, Australia
Project Leader	Dr Mike Rimmer Phone: 07 4035 0109 Fax: 07 4035 6703 Email: Mike.Rimmer@dpi.qld.gov.au
Collaborating Institutions	Secretariat of the Pacific Community, New Caledonia WorldFish Center, New Caledonia
Project Budget	\$811,857
Project Duration	01/01/2004 to 31/12/2006
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Aquaculture in the Pacific has been characterised by low production levels and few success stories. The main export commodities are non-food products (pearls and seaweed) due in large part to long transport distances and high costs. Food production has been hampered by the familiar barriers to aquaculture—post larval fish capture and culture having high mortality rates and issues of sustainability and reseeding in sea harvesting. Research has significantly advanced in terms of overcoming these barriers. ACIAR-supported research has addressed some of these issues in grouper aquaculture in Indonesia, developing methodologies applicable elsewhere, including the Pacific Islands. These countries are ideally suited to a range of aquaculture activities, having large, clean and sheltered areas of seawater and high biodiversity.

The Secretariat of the Pacific Community (SPC) has a Pacific Aquaculture Program in place to ensure the continued development of aquaculture in the region. In part this aims to address the reliance of most aquaculture developments on aid donors and domestic government agencies for assistance. The SPC Program will utilise the opportunity to link in with completed and on-going ACIAR and Worldfish work on sea cucumber, including reseeding and post larval capture and culture of aquaculture species. The results of some of this research will also be applicable for aquaculture in Australian waters, particularly far north Queensland.

The project is providing support to the SPC Pacific Aquaculture Program's strategic development of economically, socially and environmentally sustainable aquaculture in the Pacific Islands region, by:

- identifying and implementing targeted research activities and technology transfer to assist the development of sustainable aquaculture in the Pacific Island region, and
- extending the outcomes of completed and ongoing ACIAR and WorldFish projects to other communities/countries in the Pacific Islands and northern Australia.

Project progress

Year 2 (01/01/2005–31/12/2005)

This report comprises the core technical components of the project: (a) Miniprojects; (b) Capture and culture of pre-settlement coral reef fishes and invertebrates; and (c) Sea cucumber aquaculture/reseeding.

Miniprojects

Miniprojects development and implementation continued throughout 2005, consisting of:

- one large miniproject continued from 2004;
- two small miniprojects commenced in 2004 and completed in 2005;
- three small miniprojects commenced and completed in 2005;
- two small miniprojects commenced in 2005 and due for completion in 2006;
- one small miniproject approved and will commence in 2006;
- the final small miniproject developed and signed off but withdrawn due to problems in the target country.

The projects are:

- Confirmatory testing of the viral status of *Penaeus monodon* (black tiger shrimp) populations in the Fiji Islands. This project assessed the status of *P. monodon* populations in Fiji for shrimp viral diseases (e.g. IHHNV, TSV YHV/GAV, WSSV and MBV) and determined whether Fiji has populations of SPF shrimp. This knowledge has important implications for the shrimp industry in Fiji and the Pacific.
- Development of commercial and farm-made feeds for tilapia and *Macrobrachium* in PNG and Fiji. This project aims to increase production of tilapia and *Macrobrachium* in PNG and Fiji through development of commercial and farm-made feeds using inexpensive, locally available ingredients. It also involves farm trials of the formulated diets.
- Monoculture of the freshwater prawn, *Macrobrachium* lar, in Vanuatu and integrated prawn-taro farming in Wallis & Futuna. *M. lar* is an endemic prawn species that could potentially replace the introduced *M. rosenbergii* as an aquaculture species in many Pacific Island countries. This project examined growth and survival rate of *M. lar* in monoculture and in taro ponds, an important first step in assessing its potential for aquaculture.
- Rehabilitation of the mariculture research facility at Motupore Island Research Centre, Papua New Guinea. This project assessed the options and costs for rehabilitating the mariculture facilities at MIRC, including the establishment of a quarantine facility.
- Microalgae training for Tonga Fisheries technical staff. Training was provided to a member of the Aquaculture staff at Tonga Fisheries for the maintenance and scale-up of microalgae cultures in support of the aquaculture hatchery activities of Tonga Fisheries. This training was also designed to enhance capacity with respect to the proposed culture of *Pteria penguin* pearl oyster. However, the *Pt. penguin* miniproject has since been withdrawn (see below).
- Microalgae training for Samoa Fisheries technical staff. Training was provided to a member of the Aquaculture staff at Samoa Fisheries for the maintenance and scale-up of microalgae cultures in support of the aquaculture hatchery activities of Samoa Fisheries.
- Experimental release and monitoring of cultured juvenile white teatfish (*Holothuria fuscogilva*) in Kiribati. This miniproject will help determine optimal habitats for release and will monitor survival rates of the released juveniles. Such information is needed to decide whether restocking is a cost-effective and practical management option for restoring white teatfish stocks in Kiribati.
- Half pearl ('mabe') production in Kiribati. This miniproject will produce mabe pearls in Kiribati to assess their quality, provide appropriate training and produce a product to be used for value-adding activities (i.e. jewellery making).
- Village-scale sponge aquaculture in the Solomon Islands. This miniproject will assess the potential for sponge aquaculture as a sustainable income option for village communities in the Solomon Islands
- Enhancing the pearl oyster (*Pteria penguin*) resource in Vava'u, Tonga. This miniproject was designed to address a critical shortage of *Pt penguin* pearl oysters for the pearl industry in Tonga, caused by overfishing of wild adult stocks. The proposal was developed, accepted and signed off for funding at the end of 2005 but has since been withdrawn due to problems with hatchery facilities in Tonga.

Dissemination of results from miniprojects has been primarily through the SPC Fisheries Newsletter or specialist Bulletins. A further \$49 000 in funding was requested and received from ACIAR to allow implementation of additional miniprojects.

Capture and culture of pre-settlement coral reef fishes and invertebrates

This component of the project is continuing the activities of ACIAR project FIS/98/13 *Development of new artisanal fisheries based on the capture and culture of postlarval coral reef fish* (referred to as PCC), using WorldFish staff at the Nusa Tupe Field Station, Solomon Islands. Several activities occurred during 2005:

- WorldFish Center project staff continued to support established PCC operations in two villages in the Western Province of Solomon Islands throughout 2005 with visits by technical staff and assistance with aquarium product exports. Four fisher-farmers on Mbabanga Island sold 641 cleaner shrimp (worth AU\$681), 449 painted lobster (worth AU\$480) and 291 anemone shrimp (worth AU\$314). The principal fisher-farmer, Maraeki Arebaio, and his family accounted for about 96% of production and earned AU\$1,281 in 2005. This is equivalent to over SB\$8,000 which, when compared to an average village income of ~SB\$200 per month, indicates that this fishery can substantially boost rural incomes in Solomon Islands. The Rarumana community successfully lobbied for funds from their National government member and purchased ten sets of crest nets. These were deployed towards the end of 2005 and income should be forthcoming in 2006.
- WorldFish Center project staff conducted a workshop to transfer PCC technology to the town of Buala, Isabel Province, around Easter 2005. Provincial Fisheries Officers were also involved in the training. No operations have been established in this area yet but a trial shipment of fish and crustaceans was made which generated AU\$50. A follow-up trip to Kia (also in Isabel Province) was carried out in Nov-Dec 2005. No operations are established there as yet.
- Fiji was selected as the first Pacific Island country after Solomon Islands to receive training in the PCC methods. An initial training trip was carried out in May-June 2005 by Ms Cathy Hair (DPI&F) assisted by Mr Regon Warren and Mr Ambo Tewaki (WorldFish Center, Gizo). During this trip, three potential sites were inspected, fishing trials conducted and Fiji Fisheries Officers and community members trained in the techniques. Kiribati Fisheries, Tarawa, have requested PCC training. Discussions are under way between Ms Hair and Mr Tebaua Sapolu to ascertain that they meet the criteria for a PCC operation, i.e. suitable areas to deploy crest nets, interested communities with access to the collection reefs, and an established aquarium fish export infrastructure.
- The PCC methods manual for the capture and culture techniques has progressed and a draft manual is nearly complete.

Sea cucumber aquaculture / reseedling

There are three important results from the sea cucumber aquaculture research in 2005:

- juvenile sandfish produced in the 2004 spawning were on-grown throughout 2005;
- new broodstock were sourced for the 2005 spawning.
- Ms Natacha Agudo (WorldFish Center) ran a comprehensive hands-on training course for NFC project staff and trainees from PNG which produced in excess of 10,000 settled juvenile sandfish (*Holothuria scabra*).

Juvenile grow-out

About 300 sandfish juveniles from the November 2004 spawning were reared in indoor raceways at NFC until April 2005 before being transferred to bag nets for further grow-out. The bag net grow-out techniques have been developed by WorldFish Center in New Caledonia and used successfully in shrimp ponds. Four nets were used for trials in far north Queensland with small number of juveniles. Two bag net sites were tested: (1) two bag nets with 40 juveniles in each were deployed in a shrimp farm intake channel near Mosman in the wet tropics one hour north of Cairns; (2) two bag nets with 40 juveniles in each were deployed in a pond at the Oonoonba Veterinary laboratory (OVL), four hours south of Cairns in the dry tropics, where broodstock are kept. A further 40 larger individuals were placed in a pen in the same pond at OVL. Minimal care was given to the juveniles although nets were checked monthly to record growth and survival.

In summary, the juveniles in the inlet channel in Mossman showed the best growth and survival. Although it is situated in the wet tropics, this waterway has stable salinity and maintains an algal bloom at most times, providing food for the juveniles. The juveniles grown in the OVL pond experienced variable salinities and infrequent algal blooms (i.e. less food) leading to reduced growth and survival. In July 2005 all juveniles were transferred to the pen in the OVL pond as they were too large for the bag nets. These trials did not provide data for analysis but allowed project staff to gain familiarity with grow-out techniques and to assess the sites proposed for grow-out experiments using the next cohort of juveniles (i.e. planned production from the 2005–06 season).

A Masters Preliminary student from James Cook University, Ms Rachel James, used the juveniles for a small project in the last quarter of 2005. The project comprised two components, a pond trial and an aquarium trial, both aimed to examine the influence of artificial diets on grow-out of juvenile sandfish. The juveniles were enclosed in 1 m² pens in an OVL pond, half were fed extra diet of shrimp starter pellet and half were unfed. In the aquarium experiment, juveniles were fed a variety of diets and then their faeces analysed to determine what the nutritional value of the feed. Ms James plans to undertake a Masters thesis in 2006, using juvenile sandfish produced by this project during the 2005/06 spawning season. Ms James is of dual Australian and Papua New Guinean citizenship and plans to work in PNG in the future, so her training will contribute to enhanced capacity in PNG.

Broodstock

There were a number of developments with respect to broodstock in 2005. All of the 2004 broodstock died in the OVL ponds in February 2005 during a period of very high water temperatures, exacerbated by rainfall and presumed pond stratification. Attempts were made to source new broodstock from Torres Strait and Ayr but these failed and broodstock were eventually acquired again from the Nunukul Ngugi Cultural Heritage Corporation, Moreton Bay.

Training and hatchery production, Oct–Dec 2005

Ms Natacha Agudo, the hatchery manager from WorldFish Center in New Caledonia, spent 6 weeks running training in sea cucumber culture at NFC from 26 October to 2 December 2005. As well as transferring the technology to Qld DPI&F through NFC hatchery staff, two trainees from the Conservation International Milne Bay Community-Based Coastal & Marine Conservation Project (Ms Priscilla Eka and Ms Pamela Mua) were taught how to spawn and rear larval sandfish during a 6-week hands-on training course. Ms James (JCU) also participated in the training on an *ad-hoc* basis.

Sandfish were induced to spawn by using several or all of the following shock treatments: drying, cold water, warm water and addition of *Spirulina* to the tank. MB Pond broodstock spawned four times from nine attempts and MB Wild broodstock spawned twice from five attempts. Five attempts to spawn Torres Strait broodstock were unsuccessful. Ten tanks of larvae were reared but only two were maintained through to development of juveniles. One tank of approximately 5500 juveniles was transferred to a raceway conditioned with *Nitzschia closterium* as the final stage of the training course on 11 December 2005. The second tank of an estimated 7000 juveniles was transferred to the same raceway on the 22nd December. To maintain juveniles, *Nitzschia* was added to the raceway regularly to provide food. In late December, large, fast-growing individuals were transferred to a separate raceway to encourage growth of smaller individuals in the raceway. These juveniles will be used for grow-out trials in bag nets in 2006. Bag nets will be set up in the inlet channel at the Mossman shrimp farm, in an OVL pond in Townsville and in the bioremediation pond of a shrimp farm near Ingham.

FIS/2001/083: Inland aquaculture in PNG: improving fingerling supply and fish nutrition for smallholder farms

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	University of Western Sydney, Australia
Project Leader	Dr Paul Smith Phone: 02 46203329 Fax: 02 46203025 Email: pt.smith@uws.edu.au
Collaborating Institutions	National Fisheries Authority, Papua New Guinea Highland Aquaculture Development Centre, Papua New Guinea Department of Agriculture and Livestock, Papua New Guinea Queensland Department of Primary Industries and Fisheries, Australia
Project Budget	\$774,751
Project Duration	01/01/2005 to 31/12/2008
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Aquaculture is a growing industry in Papua New Guinea (PNG). Fish can provide both income and food protein but in inland areas rivers do not have a high number or diversity of species to support these needs. Farming of fish, or aquaculturing, is one avenue through which increased supply can be reached. A previous ACIAR project examined the aquaculture industry in PNG. A survey of 313 farms, as well as hatcheries, institutions and markets, revealed approximately 11,000 active fish farms. This was almost double the 6000 estimated to be in operation prior to the survey's findings. Three types of farms are in operation: newcomers to the industry who are yet to harvest, established farmers, and pioneers of the industry. One thing most have in common is never having received training in aquaculturing fish.

The survey, together with a workshop of key stakeholders, identified the main issues for research to support the industry. Of these issues two will be addressed in this follow-on project. Demand for fingerlings to fill ponds is extensive, with current supply able to meet only 10 per cent of this. The distribution network for the industry is a limiting factor, along with protocols to support hatchery operations and broodstock management. Nutritional feeds to help rear fingerlings are also in short supply. Manufactured pellet feeds are expensive and leave smallholders seeking other material. Local ingredients that support the growth of fish and utilise materials that can be prepared on-farm are also needed to support the industry's expansion. The project is working to improve the productivity (and profitability) of smallholder fish farmers in inland PNG. The long-term outcome will be increased dietary protein and better nutrition for farmers, their families and inland communities.

Project progress

Year 1 (01/01/2005–31/12/2005)

During 2005 we carried out research work and training at the Highlands Aquaculture Development Centre (HAQDEC). This facility is located at Aiyura and run by Officers of Eastern Highlands Province. It is nationally significant because it is the main fish hatchery in PNG. Also, research was carried out at laboratories in the University of Western Sydney, Hawkesbury campus. In summary, the activities that were undertaken relate to four of the five objectives i.e. Objective 2 (Develop improved on-farm feeds and fertilisers for smallholder farmers), Objective 3 (Substantially increasing the fingerling supply from HAQDEC), Objective 4 (Trial aquatic bacteria in feed to improve fish nutrition) and Objective 5 (Extend the fish husbandry package and findings to farmers). Activities relating to Objective 1 (Develop a fish husbandry package for smallholder farmers) will commence in 2006. The progress made in 2005 is summarised as follows.

Objective 2 (Develop improved on-farm feeds and fertilisers) At UWS a comparative study was undertaken on the impact of six types of fertiliser on the bacteriology of water and sediment in extensive, freshwater aquaculture. The two key factors that were investigated were the a) effect of the fertilising regime on bacterial succession in fish ponds, and b) the nutritional value for fish of the benthic and planktonic biota for each fertiliser. The fertilisers were cow manure, chicken manure, mushroom compost, dried lucerne, dried oat hay, and soluble fertiliser (urea and superphosphate). Experiments were carried out in triplicate mesocosms (50 litre volumes) and repeated. Unfertilised mesocosms were used as a control. Two variations were studied in which results for a) high vs low level of each fertiliser, and b) new vs aged sediment were compared. Funding for this study was provided by an UWS internal competitive grant (50%) and ACIAR project funds (50%). The final collection and analysis of samples will be completed in February 2006. It is hoped that the work will provide evidence for determining the most appropriate fertilising regime for extensive farming in new and aged fish ponds in PNG (i.e. for ponds without powered aeration and with low rates of water exchange). Data on types and numbers of bacteria, extracellular microbial enzymes, nutrient concentrations, biophysical measurements and survival & growth rate of fish is currently stored on Excel data bases. Draft reports are in preparation. Aquatic bacteria that have been isolated during the study will be used in Objective 5 in 2006.

Objective 3 (increasing fingerling supply from HAQDEC), progress was made in all of the six activities listed in the project document. The results will a) reduce bottlenecks at the hatchery stage of fingerling production (i.e. juvenile fish) and b) substantially increase fingerling supply to smallholder farmers throughout PNG. The enthusiastic officers at HAQDEC were assisted through visits by international experts—Dr Mohammed Akterazzaman from Bangladesh, Mr Satya Nandlal from Fiji, and Dr Geoff Allan, Mr Peter Graham and Mr Brett Herbert from Australia. Also, improvements were made in aspects of hatchery operations as a result of experiments performed by Project Officers (Ms Hopa Simon and Mr Wally Solato) and staff at HAQDEC. A summary of the activities and the results are as follows.

3.1 A major workshop, “The Hatchery Review of Operations at HAQDEC” was held from 7 to 11 November 2005 at Aiyura. More than 20 farmers and officers from 6 Provinces of PNG participated. Two experts in breeding and culture of GIFT fish were invited from Bangladesh (Dr Md Akteruzzaman) and SPC in Fiji (Mr Satya Nandlal). They generously shared their knowledge with participants and provided instructive training and extension. The Hatchery Manual should be completed by mid-2006 and it will be tested and modified by staff at HAQDEC under operating conditions. It will also form the basis of a Smallholders Hatchery Manual.

3.2 Ms Hopa Simon, one of the project’s Technical Officers, performed the experiments to determine the cause of mortalities of GIFT fingerlings during transport and to determine the appropriate protocols for ensuring high survivals during transport. Up until now, the mortalities for GIFT fingerlings have been averaging around 70-90% for trips of 3 to 4 hours, even though bags were oxygenated. It has been almost impossible to transport fingerlings to farms that are more than 12 hours from Aiyura. The research was designed to measure survival of fingerlings while testing a range of sedatives, chemicals, packing densities and water quality. A key finding was that the use of rainwater from storage tanks at Aiyura was a major cause of mortalities. By using low concentrations of salt in the rainwater, or using reservoir water, it was possible to reduce mortalities significantly.

3.3 Mr Wally Solato, our other Technical Officer, is installing a system for managing separate broodlines for GIFT. Three families of fish have been collected from the original stocks that were distributed to regions of PNG. Although only a handful of the original GIFT survived in quarantine at Aiyura in 1998–2002, the offspring that are now spread throughout many farms in the regions of PNG, have fine characteristics. There is a good argument for introducing replacement families of GIFT, however the specimens that we have observed in PNG do not suffer from deformities or other characteristics of weak, inbred fish. So we will continue with our families of broodlines and gain training as we go.

3.4 Techniques for constructing a new water bore at HAQDEC have been applied to a low lying section of the Fisheries Station. Initial tests were performed in October and a second attempt was made in November 2005. Once the necessary pipe fittings are purchased, the bore should be pumped in. Hopefully this will be completed in early 2006.

3.5 The first training and extension workshops at HAQDEC for small-scale hatchery operators was held in November 2005 at the Hatchery Review, as outlined in 3.1 (above). At the Hatchery Review smallholder hatchery operators attended from six provinces and the manual that we are preparing will extend the skills and training at the future workshops.

3.6 We have recorded the data on fingerling production and distribution by HAQDEC since 1980 for common carp and GIFT as well as for Erap since 2003 for GIFT. We have not yet made accurate records of the number of fingerlings distributed by smallholder hatcheries, however this will be attempted in 2006. The data have been entered into an Excel spreadsheet and transmitted to NFA in August 2005 for their databases. The database will be updated every 6 months.

Objective 4 (Trial aquatic bacteria in feed to improve fish nutrition) one activity has been undertaken. Aquatic microbes have been isolated and selected for testing on feeds. So far the bacteria have been cultured with a broth based on oaten straw. The growth and survival rates of atremia have been remarkable. The assessment of the bacteria's capability to improve the nutritional status of this low-value feed is being assessed. This work is ongoing and testing will expand in 2006. Funding was provided by UWS (50%) and ACIAR (50%) in 2005.

Objective 5 (Extend the fish husbandry package and findings to farmers), some skills and knowledge have been provided to the industry at the Hatchery Review (as outlined above in 3.1). At this stage only a small number of smallholder farmers benefited, however the accumulation of extension material has begun.

FIS/2002/056: Biology and status of the prawn stocks and trawl fishery in the Gulf of Papua

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	CSIRO Marine Research, Australia
Project Leader	Dr Alan Butler Phone: 07 3826 7200 Fax: 07 3826 2582 Email: alan.butler@csiro.au
Collaborating Institutions	National Fisheries Authority, Papua New Guinea University of Tasmania, Australia
Project Budget	\$479,680
Project Duration	01/07/2003 to 31/12/2006 (Project extended from 01/07/2006 to 31/12/2006)
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

The Gulf of Papua Prawn Fishery is one of Papua New Guinea's (PNG) most important fisheries. It provides a total annual catch of about 1000 tonnes, worth K10 million. Fishing in the Gulf is overseen by the National Fishing Authority (NFA), who recently allocated 10 new licenses for a small inshore prawn fishery. Little is known about the potential biological and economic impacts of the uptake of these licenses. Crucial to this is the relationship between inshore and offshore components of the prawn population. NFA managers will be better placed to plan for sustainable management based on the best options, both economic and biological, with this knowledge.

A previous ACIAR-supported project examined management of the prawn fisheries. This recommended a cap on industrial fishing and a change from management by Total Allowable Catch to Effort Targets. This and other changes instituted in data collection have established a basis for assessment in this new project that will develop and evaluate management strategies and policies for the profitable and biologically sustainable utilisation of the Gulf of Papua prawn resources.

The main project objective is to develop and evaluate management strategies and policies for the profitable and biologically sustainable utilisation of the Gulf of Papua prawn resources. The specific objective of this project is to assess the biological status and impact of varying fishing strategies and levels of effort on prawn resources. The project is assessing the potential impact of a small boat (inshore) fishery on the 'offshore' fishery and building capacity for biological research and fishery management in Papua New Guinea.

Project progress

Year 3 (01/07/2005–30/06/2006)

Work continued on all aspects of the objectives. NFA project scientist Ms Luanah Koren and data entry operator Mrs Linda Tumbu continued to work on updating the NFA logbook database. Daily logbooks from 2001 onwards were entered and historical records from 1975 to 1999 were retrieved from the government archives and entered. Data gaps and inconsistencies identified during the October 2004 project workshop were fixed or additional data gathered to help estimate the catch during these periods. Australian and PNG project counterparts worked with an external database during the reporting period to further modify the logbook database, create new routines to (1) monitor the accuracy and precision of logbook data entry and (2) compare logbook, company landings and national exports. These data when complete were then used to estimate the changes in fishing efficiency since 1974. This was found to be lower than expected and appears to be due to the fleet being composed of mostly old vessels. There were only minor improvements in efficiency until the introduction of newer vessels in the late 1990s that had previously fished in the Northern Prawn Fishery in Australia.

The National Fisheries Authority of PNG funded a third fishery independent survey of adult and immature prawns in March 2006. Before the survey, NFA staff had a community meeting in Kerema to explain the project and the purpose of the survey. A total of 92 trawls were made during the survey throughout the commercial fishing grounds and within the 3 nautical mile (nm) closure. All were either from locations surveyed in 2004 and 2005 or repeats of trawls near the 3 nm closure boundary. As in the previous years, populations of banana prawns were highest inside the 3 nm fishing closure and in the eastern part of the commercial fishing grounds. Significant catches of the valuable black tiger prawns were also made around Kerema and Freshwater Bays. The data from the three surveys have been combined to provide the basis of an assessment of the viability of a small-scale inshore fishery. This fishery will be within the 3 nm closure and be undertaken by local fishers.

An assessment of the status of the prawn populations at the June 2006 workshop found that banana prawns in the Gulf of Papua were fully or over-exploited. The current total catch of 550–600 t needs to be reduced to approximately 400 t to be sustainable. Current catch rates in this fishery were well below similar fisheries in Australia. For the fishery to remain economically and biologically viable, the total catch needs to be reduced.

FIS/2004/065: Culture of promising indigenous fish species and bioremediation for barramundi aquaculture in northern Australia and PNG

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Freshwater Fisheries and Aquaculture Centre, Australia
Project Leader	Mr Brett Herbert Phone: 07 40929913 Fax: 07 40933903 Email: brett.herbert@dpi.qld.gov.au
Collaborating Institutions	James Cook University, Australia Ok Tedi Mining Ltd, Papua New Guinea National Fisheries Authority, Papua New Guinea Western Provincial Administration, Papua New Guinea
Project Budget	\$781,587
Project Duration	01/06/2006 to 30/06/2011
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Locally available protein sources for highland subsistence farmers in Papua New Guinea are limited. Production constraints minimise cash purchases of protein sources. One potential solution is aquaculture of suitable freshwater native fish and crustaceans. Earlier exploratory research identified possible species for aquaculturing, based on techniques developed for freshwater species, such as barramundi, by the Queensland Department of Primary Industries and Fisheries. Proving hatchery production and growout techniques for these species in PNG highland ponds, and fostering extension through Ok Tedi Mining Ltd (now a major employer but due to close in 2012) is being undertaken. On-farm trials with farmers are being used to test these techniques. An Australian component is examining environmental impacts and their management for barramundi farming in Queensland.

Project progress

First progress report due in 2007.

FIS/2005/096: Assessment of the impact of the PNG purse seine fishery on tuna stocks, with special focus on the impact of fish aggregation devices (FADs)

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Secretariat of the Pacific Community, Oceanic Fisheries Programme, New Caledonia
Project Leader	Dr John Hampton Phone: 687 260147 Fax: 687 263818 Email: johnh@spc.int
Collaborating Institutions	National Fisheries Authority, Papua New Guinea University of Hawaii, USA
Project Budget	\$400,000
Project Duration	01/05/2006 to 31/12/2009
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

The tuna fishery in Papua New Guinea—the largest in the Pacific Islands region, is based on total allowable catches allocated by species type (skipjack, yellowfin and bigeye tuna) and gear type (purse seine and longline). Overfishing of tuna stocks, due in part by the use of anchored fish aggregation devices (FADs), may have a negative impact on the sustainability of the tuna fishery in the region. The objective of this ACIAR's project is to manage the sustainability of the tuna fishery by providing information on tuna population dynamics and fishery impacts for the use of FADs. The project is providing information on the impacts of fishing in the PNG Exclusive Economic Zone that will constitute the basis for appropriate management actions by the PNG National Fisheries Authority (NFA), and contributing to regional stock assessment and fishery management.

Project progress

First progress report due in 2007.

FIS/2006/001: Increasing capacity for regional fish feed manufacture in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	NSW Department of Primary Industries, Port Stephens Fisheries Centre, Australia
Project Leader	Dr Geoff Allan Phone: 02 4916 3909 Fax: 02 4982 1107 Email: geoff.allan@dpi.nsw.gov.au
Collaborating Institutions	National Fisheries Authority, Papua New Guinea
Project Budget	\$48,664
Project Duration	01/06/2006 to 30/11/2006
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Inland aquaculture in PNG is set on a slow growth path despite approximately 11,000 small aquaculture farms. Major constraints of this activity comprise access to fingerlings and feeds manufacturing. At present, there is no manufacture of aquaculture feeds in the country and imported ones are very expensive. This ACIAR's project focuses on building capacity of farmers in basic fish nutrition and feed manufacture and on-going support to establish four regional feed manufacturing centres at selected areas. These feed manufacturing centres will act as feed distribution centres in order to link feed production with fingerling distribution. Yet, the project will help farmers increase their understanding of the fish nutrition and feeding and their skills of aquaculture feeds in PNG.

Project progress

First progress report due in 2007.

FST/2003/049: Review of portable sawmills in the Pacific: Identifying the factors for success

Overseas Collaborating Countries	Papua New Guinea, Solomon Islands
Commissioned Organisation	Australian National University, School of Resources, Environment and Society, Australia
Project Leader	Dr Ryde James Phone: 02 6125 4330 Fax: 02 6125 0746 Email: ryde.james@anu.edu.au
Collaborating Institutions	Secretariat of the Pacific Community, Fiji University of Melbourne, Australia Papua New Guinea Forest Authority, Papua New Guinea Papua New Guinea Ecoforestry Forum, Papua New Guinea University of Technology, Papua New Guinea Ministry of Forestry, Environment and Conservation, Solomon Islands Solomon Islands Development Trust, Solomon Islands
Project Budget	\$149,989
Project Duration	01/04/2005 to 30/09/2006
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Portable sawmills are cheaper to use than conventional mills, causing less collateral damage than conventional harvesting. One important benefit is in allowing small-scale operators to undertake high-quality sawmilling and gain much of the value added in the production of milled forest products. These benefits saw more than 7000 portable mills purchased throughout the Pacific. Less than 20 per cent are believed to be operating effectively. A lack of technical expertise, poor maintenance and market accessibility are behind this low rate. These causal factors are being evaluated by studying a range of mill operations to design strategies for more effective usage. Appropriate recommendations will then be provided to key stakeholders for dissemination.

Project progress

Year 1 (01/04/2005–31/03/2006)

This project has had a slow start being first approved in 2003 under the Leadership of Dr Digby Race. While Dr Race's planning was excellent and we are still following his outline, his change of employment and other changes in personnel have meant that progress has been slower than we would have liked. There was also some difficulty in finding a time during which all participants could travel to the field to carry out the actual data collection phase.

To date however the most work intensive phases have been completed or are in progress. The quality of the investigations that have been done is high and a successful ending to the project is anticipated. The project is, so far, within budget.

The project has brought together researchers and experts from: The Secretariat of the Pacific Community (Sairusi Bulai—Fiji), Solomon Islands (Gorgon Konairamo and Terence Titulu), Papua and New Guinea (Anda Akivi) and Australia (Hartmut Holzkecht, Ken Groves and Ryde James from the Australian National University and Digby Race from Charles Sturt University). The group of experts met in Canberra in July 2005 to plan two visits to PNG and the SI to collect data and to draw up conclusions concerning their findings.

Discussions during the meeting confirmed that a considerable amount is known about the operations of portable sawmills although this may not be well documented. It seems clear that where portable sawmills are used to mill forest owned by a community, they can be very successful, especially where the product is used to construct houses for the owners or facilities for the whole community. In that case success will not be measured in financial terms and the sawmill may not be used for very long. However community objectives will be satisfied. Indeed this type of use may be amongst the better forms of use for these mills.

However the group was aware that the mills could be used in a manner similar to normal commercial operations and that the situation needed to be checked by field observation.

Overview of status of sawmills:

This was completed on time by country representatives and the SPC. It provides detailed background information for the Solomon Islands and Papua and New Guinea. This was essential to familiarise other members with the situation on the ground in those two countries. It dealt not only with community based mills, but also those run as commercial businesses. Even in the case of milling to provide house materials, it is usual to sell some wood to finance the hardware and fittings components of the building. It was therefore suggested that all sawmilling would have a commercial element to it.

As well, some operators of sawmills are entrepreneurs and operate entirely on a commercial basis. Sales can be for internal consumption, but where infrastructure allows, is increasingly for export. The relationship between forest resource owners, mill owners and timber traders (including exporters) is complex. In many cases these are the same people and conflicts do not arise. However there may be some conflicts of interest where they are different enterprises.

It was noted that the rules under which portable sawmills are allowed to operate in PNG and SI were designed on the assumption that the mill owner and forest owner were the same. The report drew attention to possible conflicts in the regulations and the way in which they are currently applied. An assessment of previous reports on this subject has been prepared by Ken Groves and Hartmut Holzkecht. Coordination of the two sections of the report is nearing completion.

Field visit to PNG

In April 2006 most of the team visited PNG for two weeks. The first part was taken up with an 'Inception Meeting' in Port Moresby to explain the purpose of the trip to officials of the PNG Forest Authority and others. We also visited the provincial office in Lae and inspected mills in the environs of Port Moresby, Lae and the head of the Markham Valley near Goroka, attended a one-day seminar of forest and mill owners in Lae, and met members of NGOs (e.g. *Village Development Trust* and *Habitat for Humanity*) in Port Moresby, Lae and in the field.

Tentative conclusions:

The technology of sawing has been mastered sufficiently well in PNG for us to say that although it was not perfect, this is not where the major problems lie. Training schemes exist through the Timber Industry Training Centre in Lae, and also from mill suppliers, so that the operators that we observed were all capable of using their mills. Forest owners were producing timber by themselves, or with the aid of NGOs. Houses were being built from this timber and the aims of the people were being satisfied.

Faults which did exist with the sawing process largely concerned the way in which sawing impinged on other values such as forest management. Selection of trees to harvest was based entirely on convenience of location and of the marketability of the species. The degree of utilisation of felled trees could be poor especially when logs that were inconvenient to saw were just left. Utilisation was therefore lower than it could have been, both because of difficult logs and because only timber sizes which suited the market (house lots) were taken; the rest being wasted. Care of boards after sawing was often rudimentary, but the species used were of such high quality that the timber did not deteriorate.

It should be noted that all these faults were understandable. Possibly the easiest part of the process was the actual sawing. Transport of the mill to the fallen tree over steep terrain was difficult; as was carrying out the sawn produce. Many comments were made at meetings that using a portable sawmill was actually 'back-breaking' work. Unfortunately, in PNG, humans still do manual work that in developed countries is left to machines.

However, the problem areas were in the social, economic and regulatory fields. Social cohesion varied amongst the people of PNG as it does anywhere. Some family groups were very well organised but other groupings could be less so and the use of portable sawmills could fail or be successful on those grounds alone.

In only the EU funded 'Eco-Forestry' project did we see milling where the trees had been selected on proper silvicultural criteria. In that case, the stand of 10.5 ha had been competently surveyed, trees numbered, felling direction decided and volume assessed. Only trees making up 25% of assessed volume could be taken and there was a long, specified, return time. In all other cases, fellers took the next convenient tree. This was quite understandable as the people involved had no concept of sustainable forest management. Mills were located on the most convenient piece of level ground without regards to the consequences (in one case over a dry watercourse where the sawdust and debris would be carried away in the next storm). If any improvement could be made it would be to provide a cheap method of extraction so that more of the produce could be extracted and used. In one case buffaloes were being trained to bring out a small rubber tyred cart loaded with wood. This would greatly improve the degree of utilisation as the distance from mill to road was often long and the terrain difficult to traverse when carrying timber. Better extraction would result in better utilisation percentage and fewer trees being required to fulfil the quota for each house-lot.

In terms of judging success, the mills appeared to be more successful than had previously been supposed. However the criteria were not simply economic. If a mill had been bought so that the owners could saw enough timber to build a house, and this had happened, then the mill was regarded as a success and the fact that it was no longer used should not represent failure. The mill owners had often not acquired the mill to become sawmillers but rather to become house owners. Once the house had been built, then the project was regarded as successful; at least by the house owner. If the mill did not make a profit in terms of finance, then it could still be successful; particularly if the mill was used by another potential house-owner.

On the other hand PNG mill owners showed only a short-term awareness of finance, often making too little allowance for longer-term effects such as costs of repairs or replacement of parts. Running costs such as fuel and sharpening of saws were also often neglected.

The legal regulations under which portable sawmills operate in PNG need to be revised. It was intended that the mills could operate completely without regulation if their cut was less than 500 cubic metres per year. The reasoning being that: the volume was too small to be a problem and the owners were cutting their own forest anyway. In fact, mill sponsors were using this quite high figure to purchase timber from many mill 'owners' they had sponsored. It was said that one person had sponsored or owned 11 such mills and one we met admitted that he had bought one mill that was so profitable that he was going to buy another. It was suggested at the seminar held in Lae that the system would work better if a zero could be knocked off the figure; i.e. down to 50 metres cubed. It was also suggested that instead of a volume, permission to mill might be better defined by land area and that this value should vary by the type of ownership group, i.e. family, clan or larger community.

Portable sawmill owners were not organised and a Portable Sawmill Owners Association would be helpful; for advice when recasting the regulations and perhaps for some degree of self-regulation of activity.

The areas that needed more work were seen as: social organisation of owner groups, forest operations, especially how trees were chosen to be felled and the business arrangements and the regulations for small mill exemptions. Whether these conclusions are confirmed as a result of the trip to the Solomon Islands has yet to be seen. However the group felt that we had learnt a great deal from the trip that would assist us to derive positive conclusion for the way forward.

FST/2004/009: Facilitating the availability and use of improved germplasm for forestry and agroforestry in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Mr Brian Gunn Phone: 02 6281 8258 Fax: 02 6281 8266 Email: brian.gunn@csiro.au
Collaborating Institutions	Queensland Department of Primary Industries and Fisheries, Australia Papua New Guinea Forest Research Institute, Papua New Guinea The Foundation for People and Community Development Inc., Papua New Guinea
Project Budget	\$627,169
Project Duration	01/04/2005 to 31/03/2008
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Harvesting of native, primary forests has been an important export industry for Papua New Guinea (PNG). Logs are exported mainly by foreign logging companies, providing very substantial returns totalling hundreds of millions of kina. This money flows to the PNG Government, local communities and landowners. Continued harvesting has depleted primary forests, but those areas replanted with secondary forests have produced less reliable yields. As primary forests are rapidly depleted the likelihood of lost income earnings is growing nearer. This is despite a growing international demand for sustainably produced high-value timber. Papua New Guinea has extensive areas well suited to growing trees. A climate favourable for several in-demand species, good soils, and knowledge of forestry and agroforestry support potential new plantings.

The knowledge of forestry and agroforestry systems has grown from a tradition of tree planting by communities and families. While the plantation sector lacks the scope to expand in a significant way smallholder community-based and family-based plantations and agroforestry enterprises do have the capacity to expand. One element that will support this growth is developing community tree-planting programs. This includes activities undertaken in this project—providing germplasm for high-value timber species and training in propagation being two of several activities designed to address issues relating to expanding community involvement in agroforestry.

This project has two main aims: first, to improve and make available selected tree germplasm and planting stock for use in forestry and agroforestry in Papua New Guinea and humid tropical parts of Australia; second, to empower PNG rural communities to raise their own trees.

Project progress

Year 1 (01/04/2005–31/03/2006)

The project effectively started in August 2005 with an inception meeting held at FRI Lae.

Objective 1. Establish and maintain germplasm populations for 10 tree species.

A strategy plan was developed for each of the 10 target species as a starting point for implementation of this activity. The following activities have been undertaken to 31 March 2006 for each of the species:

Teak (Tectona grandis): Under separate funding, a 'review of available germplasm of teak in PNG' has been undertaken and report prepared. Report information will be used to determine the genetic sources to be used in development of a new seed orchard. Seed orchard seed from Thailand has been imported in to PNG to supplement local germ plasm sources.

Taun (*Pometia pinnata*): Seedlings are being raised in readiness to graft on selected vegetative material derived from trees identified to produce superior fruit. If grafting does not prove successful, the seedlings derived from fruit being sold in the Madang markets will be used to establish a seed stand.

Eaglewood (*Gyrinops ledermannii*): FRI has 25 unrelated source plants which are being used to build up the number of plants using cutting propagation techniques.

Indian sandalwood (*Santalum album*): 950 seedlings from genetically improved seed source are being raised at the FRI nursery. The plants will be planted by FRI as a seed stand and distributed to selected growers as a source of future seed.

PNG sandalwood (*S. macgregorii*) seedlings are being raised at FRI nursery for use as rootstocks for grafting on scion material from wild populations in an ongoing attempt to conserve the genetic diversity of the species.

Eucalyptus pellita and *Acacia crassicarpa*: Genetically superior seed is being raised by FRI for use in establishing seed production areas of these two species.

Objective 2. Training rural communities in tree planting (seed collection to tending planted trees)

A number of NGO organisations interested in working with communities to establish trees have been engaged under the project. A meeting was held at the commencement of the project to brief representatives from each of the five NGOs together with FRI. Following this workshop, approximately two nursery trainers from each NGO group attended a two-week nursery training course. Following the meeting and workshop, NGO staff have been developing links with representative communities associated with their organisations.

Objective 3. Genetically improved eucalypt germ plasm

3a. *E. deglupta* clonal seed orchard (CSO) in PNG—Selections from the existing *Eucalyptus deglupta* CSO, seedling seed orchard and 'Philippines' stand at Bulolo have been made for use in establishing a new CSO. Scion material from all 19 clones in the CSO has been successfully grafted on to rootstocks. An additional 800 rootstocks are currently being raised in the FRI nursery for the purpose of grafting scions from an additional 30 selected clones. A site at Bulolo is being prepared in readiness to plant the new CSO.

3b. Develop hybrid between *E. deglupta* x *E. pellita*—10–15 clones grafted above are earmarked for carrying out hybrid cross using *E. pellita* as the male once the *E. deglupta* grafts flower. *E. pellita* from seed orchards in north Queensland, derived mainly from PNG and West Irian, has been collected in readiness for the controlled crosses.

3c. Eucalypt hybrids in Queensland—The first round of *E. urophylla* x *E. pellita* controlled-pollinations were undertaken at two locations in north Queensland, over a two week period in February–March 2006. Twenty individual mother trees—seven from a family trial at Kuranda and thirteen from a family trial at East Palmerston—were used for the controlled pollination work.

Additional pollen was collected from the *E. pellita* seed orchards for future pollination of other eucalypt species. Future planned hybrid crosses include *E. grandis* x *E. pellita*, *E. camadulensis* x *E. pellita* and *E. urophylla* x *E. pellita*.

FST/2004/055: Domestication and commercialisation of *Canarium indicum* in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea, Solomon Islands
Commissioned Organisation	James Cook University, School of Tropical Biology, Australia
Project Leader	Professor Roger Leakey Phone: 07 4042 1573 Fax: 07 4042 1319 Email: roger.leakey@jcu.edu.au
Collaborating Institutions	National Agricultural Research Institute, Papua New Guinea Cocoa and Coconut Institute, Papua New Guinea Commodities Export Marketing Authority, Solomon Islands Kastom Gaden Association, Solomon Islands Pacific Nuts Co., Vanuatu
Project Budget	\$634,571
Project Duration	01/01/2006 to 31/12/2009
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

The feasibility of domesticating and commercialising the canarium nut in Papua New Guinea was established by past ACIAR research. Building on those findings is the aim of this research; to ensure sufficient supply of *Canarium indicum* and to establish a network for this. The nut is currently used for food but supply falls well below demand. Selecting cultivars that produce nuts regularly and fruit heavily will close this gap. Establishing robust nursery propagation techniques using low-cost systems suitable for community and village uptake will help create a more regular supply of high quality fresh nuts, which can underpin the development of a marketing network.

Project progress

First progress report due in 2007.

PLIA/2005/148: Papua New Guinea coffee and cocoa policy linkages scoping study

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Centre for International Economics, Australia
Project Leader	Dr Derek Quirke Phone: 02 62457800 Fax: 02 62457888
Collaborating Institutions	
Project Budget	\$47,500
Project Duration	12/12/2005 to 31/08/2006
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

This scoping study aims to assess the policy and institutional environment affecting the development of the coffee and cocoa industries in PNG, and advise; whether this environment is likely to have an impact on current and potential ACIAR projects; indicate the nature and potential significance of these impacts; advise if a policy linkage/economic analysis project is required for each industry to complement technical projects; and identify key personnel involved in policy formulation and decision-making relevant to the issues raised in order to suggest people to engage with and involve in future policy linkage projects. This scoping study will result in the development of an SRA on policy linkage for the coffee and cocoa industries.

Project progress

First progress report due in 2007.

SFS/2001/036: Maximising the economic benefits to Pacific Island Nations from management of migratory tuna stocks

Overseas Collaborating Countries	Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tuvalu, Vanuatu
Commissioned Organisation	La Trobe University, School of Economics, Australia
Project Leader	Dr John Kennedy Phone: 03 94792313 Fax: 03 94791654 Email: j.kennedy@latrobe.edu.au
Project Web Site	http://www.business.latrobe.edu.au/staffhp/jkennedy/ACIARTechPapers.htm
Collaborating Institutions	University of Queensland, Australia Secretariat of the Pacific Community, New Caledonia Forum Fisheries Agency, Solomon Islands
Project Budget	\$577,584
Project Duration	01/01/2002 to 31/12/2007 (Project extended from 01/01/2006 to 31/12/2007)
ACIAR Research Program Manager	Dr Simon Hearn

Project background and objectives

Stocks of tuna migrate through the exclusive economic zones (EEZs) of island nations in the Western and Central Pacific Ocean. The migratory nature of the tuna means that no nation has control over the tuna stocks. Over the last decade the proportion of Pacific tuna caught by island nations has risen substantially, and at the same time, the level of purse seining by distant water fishing nations has also risen significantly.

A bioeconomic model (developed in an earlier ACIAR project) of the Pacific tuna fishery has been used by the Forum Fisheries Agency and the Secretariat of the Pacific Community to identify and analyse various concerns associated with increased purse seine catching. One of the negative impacts identified is that increased purse seining reduces catch of larger (older) and higher priced tuna caught by longliners and sold fresh. A second concern identified with the model is that the traditional method of charging the purse seine fleets of distant water fishing nations for access to the EEZs of the Western and Central Pacific Ocean is not maximising the flow of annual rents from tuna harvesting to island nations. A third issue is that excess vessel capacity has built up in the fleets that harvest the tuna, which has led to economic inefficiencies in harvesting.

The project is identifying and promoting strategies for Pacific Island Nations to maximise the economic benefits from their migratory tuna stocks. The aim is to determine the economic negotiating positions of Pacific Island Nations (PINs) that have rights to stocks of migratory tuna passing through their economic fishing zones, and the Distant Water Fleet Nations (DWFNs) such as Japan, USA, South Korea, Taiwan and China that are interested in paying for access to the stocks. This relies on interactive modeling of the optimal access offers of the PINs and the optimal harvesting decisions of the DWFNs.

Project progress

Year 4 (01/01/2005–31/12/2005)

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific was installed in December 2004, under the auspices of the United Nations Fish Stocks Agreement, which came into force in 2001. The Commission is investigating alternative management measures for ensuring stocks will be effectively managed and that catches will be sustainable. The modelling resources developed in this project will enable estimates to be made of the producer rents flowing to different fishing fleets targeting different tuna species, inside and outside the exclusive economic zones of the PINs, from alternative regulatory measures.

Objective 1: Updating and extending the capability of the bioeconomic tuna model:

Extending modelled fleet coverage

Domestic fleets of the Philippines and Indonesia and the troll fleet targeting albacore operating in the Pacific were added to the model. The range of purse seine fleets was increased from the original four (Japan, Korea, Taiwan and the US) to include fleets for the Pacific Islands, Western and Central Pacific Ocean, and Eastern Pacific Ocean.

Extending the area of modelled fishing effort

Previously the model decision variables were harvesting effort by each fleet within the region covered by the Forum Fisheries Agency (FFA). Fleet harvesting efforts outside the FFA region are now included as decision variables.

Updating biological parameters

Age classes for all four tuna species are by quarter (previously albacore was by year). Natural mortality is specified by quarterly age class, instead of constant across all ages. Changes were instituted to make the harvest function selectivity coefficients dependent only on gear type (purse-seine, pole and line, and longline), instead of on fleet and gear type.

Effort and stock exponents in the harvest functions used in the model had been set at one following widespread practice. Empirical estimation showed that WCPO purse seine stock exponents for skipjack were better set at 0.7, and for yellowfin at 0.3. Changes have been made accordingly in the updated model.

The match between modelled and observed catches was improved by estimating catchability coefficients for each fleet, this time allowing the coefficients to be different for harvesting effort inside and outside the FFA region.

Adjustments have been made to parameters determining recruitment of young fish stock to fisheries in the fishing areas of the Philippines and Indonesia. These were to correct for perceived modelled shortfalls in recruitment in these areas.

Objective 2: Analyse strategic policy options facing the nations of the FFA

The following analysis was conducted with the updated model:

i) Changes in purse seine effort on catch per unit effort (CPUE) and economic rents in the purse seine fishery

The previous model predicted a 10 per cent reduction in fishing effort would increase rents by 55 per cent. The updated model predicted an increase of only 40 per cent.

ii) Effect of an increase in purse seine catchability of yellowfin and bigeye on longline catches and fishery revenue

Repeating tests for increases in purse seine catchability of 50 per cent carried out with the previous model, the updated model confirmed that in the case of yellowfin the overall value of the fishery increased, but decreased for bigeye. The results from the updated model were more pronounced.

iii) Effect of effort reduction across all fisheries on catch and economic rents

Results from the updated model showed that reducing effort level across all fisheries by 30 per cent leads to substantial percentage increases in rents for all fisheries (purse seine, pole and line, frozen longline and fresh longline), inside and outside the FFA region, except in the case of the fresh longline fishery within the FFA region, for which the rent reduction was 2 per cent. Of particular interest is the distribution of gains across the fisheries. The frozen long-line fishery gains to a much greater extent than the purse seine, pole and line and fresh longline fisheries.

SMCN/1998/028: Diagnosis and correction of nutritional disorders of yams

Overseas Collaborating Countries	Papua New Guinea, Tonga, Vanuatu
Commissioned Organisation	University of Queensland, The School of Land and Food Sciences, Australia
Project Leader	Dr Jane O'Sullivan Phone: 07 33654811 Fax: 07 33651188 Email: j.osullivan@mailbox.uq.edu.au
Collaborating Institutions	Ministry of Agriculture and Forestry, Tonga Department of Agriculture Livestock and Horticulture, Vanuatu National Agricultural Research Institute, Papua New Guinea
Project Budget	\$1,101,049
Project Duration	01/07/1999 to 31/12/2006 (Project extended from 01/08/2005 to 31/12/2006)
ACIAR Research Program Manager	Dr Christian Roth

Project background and objectives

Yams are staple foodstuffs in many developing tropical countries. Along with their importance in the diet, they also have great cultural significance in many Pacific nations. In addition, they provide income for semi-subsistence farmers, and export revenue for some countries. In 1995 the Pacific crop was around 288,000 tonnes (or around 42 kg per capita), making it the Pacific's third most important food crop. However, yam production in many Pacific nations has been falling, as intensified farming of other crops has taken over from smallholder production. Imported foodstuffs, often less nutritious than yams but cheaper, are starting to replace yams in the diet. This has serious health implications for the population.

There is still a preference for yams among the islanders, but consumers find the prices too high compared with imported foodstuffs, while farmers are discouraged from growing more than their own needs by a feeling that the prices are too low for what is a labour-intensive crop. Part of the reason for the rather high cost of yam production is the low yields obtained by farmers for the effort invested. This is caused mainly by soil nutrient deficiencies that are reducing both growth and tuber production by the plants. This project is providing information to help in the diagnosis of nutritional disorders affecting yam plants, prior to developing feasible options for improving crop nutrition in affected areas.

Project progress

Year 7 (01/07/2005–30/06/2006)

Marie Melteras (Vanuatu project research officer and John Allwright Fellow) submitted her Masters of Philosophy thesis in July 2005 before returning to Vanuatu. The title of the thesis is 'Soil fertility as a factor affecting the production of yams (*Dioscorea* spp.) in Vanuatu'. The thesis examiners' reports were received in November, recommending a number of minor changes. These were completed and the revised thesis submitted in July 2006.

Dr. O'Sullivan completed work as contracted on the PNG project reports in July 2005. In September, she attended the 13th International Plant Nutrition Colloquium in Beijing, with support from the Plant Nutrition Trust (Alf Anderson Award). She presented a poster entitled *Interpretation of tissue analysis for potassium nutrition in tropical root crops dependent on sodium concentration* describing work resulting from the Masters program of Sharryl Ivahupa, a John Allwright Fellow under ACIAR LWR2/1991/01. A more detailed account of this work was published in the *Journal of Plant Nutrition* in June 2006 (Volume 29(6), 1095–1108).

September also saw the completion and publication of the internet and CD resource *Sweet potato DiagNotes*, the product of ACIAR SMCN/2000/060. The product has been widely acclaimed. The internet version is available at [http://www.lucidcentral.org/keys/sweet potato](http://www.lucidcentral.org/keys/sweet%20potato).

A paper on nutritional deficiencies of *Dioscorea alata* was accepted for publication by the Journal of Plant Nutrition, and will include two colour plates containing 23 images of deficiency symptoms. The cost of publishing the colour plates was covered by ACIAR in the current extension budget.

Manuscripts of three papers resulting from the project were drafted in October-December 2005 and circulated for co-author comment. These have since been submitted for publication. Of the work identified to be completed in the 2006 extension period,

- the slide collection of symptoms of nutritional disorders in yams (1600 slides) has been scanned at high resolution to a digital database. This is yet to be annotated.
- the leaf analysis samples identified as requiring reanalysis have been rerun, completing the primary data from the project.

Work remaining includes completion of data analysis and compilation of results.

SMCN/2000/046: Overcoming magnesium deficiency in oil palm crops on volcanic ash soils of Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	CSIRO Land and Water, Davis Laboratory, Australia
Project Leader	Ms Suzanne Berthelsen Phone: (07) 4753-8534 Fax: (07) 4753-8600 Email: Suzanne.Berthelsen@csiro.au
Collaborating Institutions	Oil Palm Research Association, Papua New Guinea James Cook University, Australia
Project Budget	\$917,638
Project Duration	01/07/2002 to 30/09/2007 (Project extended from 01/07/2007 to 30/09/2007)
ACIAR Research Program Manager	Dr Christian Roth

Project background and objectives

Palm oil is the most valuable agricultural commodity in Papua New Guinea (PNG); in the year 2000, it was worth about A\$152 million. About 60 per cent of production is in West New Britain Province, which has coarse volcanic soils and an annual rainfall of more than 3000 mm. Oro Province is also an important producer of palm oil. Most palms in both regions suffer from leaf yellowing, which is usually a symptom of magnesium (Mg) deficiency and which results in decreased yields. Many soils are also deficient in potassium and nitrogen.

In most parts of the world, Mg deficiencies can be corrected by applying kieserite, a soluble Mg fertiliser. However, this is not effective in West New Britain, probably because a high concentration of calcium in the soil causes Mg to leach rapidly through the soil when it is applied in soluble form. The application of nitrogen exacerbates the problem. In other parts of PNG, kieserite also fails to solve the problem, evidently because high rainfall makes it difficult for the Mg to remain in the root zone for long enough to have an effect. In both areas, the problems affect other crops as well as oil palms.

The aim of this project is to increase yields of oil palm in Papua New Guinea (PNG) by finding suitable ways to overcome deficiencies in magnesium and other elements. In particular, the project will help oil palm plantations to predict the areas likely to be susceptible to Mg deficiency and to choose the best solution for the particular soil and climatic conditions.

Project progress

Year 4 (01/07/2005–30/06/2006)

All field trials (Waisisi, Walindi and Kumbango in WNB, and Mamba in Oro) are now well established. The trial sites at Walindi, Kumbango and Mamba are in their first full year of yield recording following application of treatments, and it is unlikely at this stage for there to be any positive responses to the treatments on FFB yield. At the Waisisi site, application of Mg has significantly reduced the number of fronds with Mg deficiency symptoms—however, there is still no clear yield response to the Mg treatment. One reason for this is that the palms may not yet be Mg deficient. In the MgO treatment, the concentration is still above the concentration generally regarded as adequate. However, the three-monthly analysis of the leaflet of frond 17 shows that the tissue Mg concentration is slowly dropping, so these palms may be experiencing Mg deficiency soon.

At both Waisisi and Mamba there are some interesting interactions between Mg and K supply and Mg and K tissue concentrations. At Waisisi application of Mg has substantially suppressed rachis K concentrations, well below the adequate concentration. This could be inducing a K deficiency that is limiting FFB productivity. Early results from Mamba show that as the source of Mg becomes less soluble, (i.e. kieserite > magnesite/dolomite > MgO) the concentration of K in the rachis increases.

Results from glasshouse solution culture trials support the field observations and have clearly demonstrated that high levels and activity of Mg or K in the soil solution can reduce the uptake of the opposing ion due to cation competition. The effect of this cation competition highlights the challenge of applying appropriate rates of both K and Mg fertiliser in situations when soil has deficient levels of either one or both of these nutrients.

During this reporting period a number of field and laboratory activities were initiated as part of the expansion phase of the project. This new work includes potassium in addition to magnesium, and aims to gain a better understanding of the soil chemical and physical processes that make them susceptible to loss. Extensive sampling has been carried out at existing K rate trials to determine the fate (loss or accumulation in the soil) and nutrient use efficiency of the K that has been applied annually over the last 13 years.

At one site (Trial 502, MBP), an estimated 67% of the applied K was taken up by the palms at the lowest rate of applied K. As the rate was increased to 2.5 kg K per palm (a typical application rate for blocks around the trial, the percentage recovery was reduced to about 50%. At higher rates the recovery was further reduced to 35% of that applied. At this same site, soil analysis demonstrated that any K fertiliser that had not been taken up by the palm could be accounted for, and approximately 75% was still present in the top 40 cm of the soil profile as either 'exchangeable' K or had become 'fixed' to the clay minerals. Determination of soil mineralogy from this and other sites illustrate the importance of taking the soil chemical, physical and mineralogical characteristics into consideration when developing a K fertiliser strategy.

Cation speciation in soil solution and in an exchange situation has been modelled on the various soil horizons, with or without additions of various Mg fertilisers at various concentrations, on representative heavier and lighter textured soils of WNB. The most useful insight to date is that a large portion of the Mg added in kieserite exists as $MgSO_4^0$, which will be much more likely to be lost by leaching than Mg^{2+} . The alternative fertilisers MgO and $MgCO_3$ maintain a higher proportion of Mg in solution as Mg^{2+} , which is likely to reduce potential leaching losses.

This observation could help explain the large leaching loss of Mg which was recorded following two leaching events in the kieserite treatments in a glasshouse pot study. This pot trial ran for over two years and compared a number of different Mg amendments at a high and low rate, either mixed throughout the soil or placed on top of the soil surface. Apart from demonstrating the high solubility and loss of kieserite, plant and soil data collected when the trial was harvested also demonstrated a negative impact on growth in the treatments receiving high rates of the two fully calcined magnesium carbonates (EMag 45 & EMag 500). These two products are very alkaline and if placed in a concentrated area (such as a 'hotspot') is likely to cause the surrounding soil to have a very high pH and be inhospitable to root growth.

Root mass distribution under oil palm has been measured at Sangara and compared to root activity determined by measuring water uptake. Root mass decreased more markedly with depth than root activity, possibly because water uptake per unit of root mass increased with depth, and probably because root mass at depth was underestimated due to the difficulty of separating fine roots from the clayey soil at depth. The lateral distribution of root mass was similar to that of root activity.

Scientific and social impacts of the project have accrued through the experimental results and through the various training activities. Papuan New Guinean scientists, university students and extension and field staff have benefited from workshops and training in soil science, plant nutrition and related subjects.

ASEM/2004/047: Sustainable management of coffee green scales in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	CAB International, UK
Project Leader	Dr Peter Baker Phone: 44 491 829129 Fax: 44 491 829123 Email: p.baker@cabi.org
Collaborating Institutions	PNG Coffee Industry Corporation, Research and Growers' Services Division, Papua New Guinea University of New South Wales, School of Biological, Earth and Environmental Sciences, Australia
Project Budget	\$621,960
Project Duration	01/04/2006 to 31/03/2009
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Coffee is the largest earner of foreign exchange with PNG. It is largely produced by smallholders in the highlands. Productivity of coffee has been hindered by inadequate pest management, deficiencies in quality management and marketing. The main pest to coffee in PNG is coffee green scale, which on average reduces high yield crops by 10 per cent. This project will develop and foster uptake of biological control over other integrated strategies for coffee green scale. The project will document baseline information on the distribution, impacts, biology and control of coffee green scale in the coffee growing zones in PNG. It will evaluate biological and other methods of coffee green scale, taking into account grower information, and develop regional and national strategies for wider evaluation and implementation of coffee green scale control.

Project progress

First progress report due in 2007.

CP/2005/136: Mitigating the threat of banana *Fusarium* wilt: understanding the agroecological distribution of pathogenic forms and developing disease management strategies

Overseas Collaborating Countries	Indonesia, Papua New Guinea
Commissioned Organisation	International Plant Genetic Resources Institute, INIBAP Asia and Pacific Office, Philippines
Project Leader	Dr Agustin Molina Phone: 63 2 8450563 Fax: 63 2 8911292 Email: a.molina@cgiar.org
Collaborating Institutions	Queensland Department of Primary Industries and Fisheries, Australia Indonesian Fruit Research Institute, Indonesia National Agricultural Research Institute, Papua New Guinea National Agriculture Quarantine and Inspection Authority, Papua New Guinea Agency for Agricultural Quarantine, Indonesia
Project Budget	\$445,274
Project Duration	01/06/2006 to 31/05/2009
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Banana is widely grown in tropical regions throughout Asia and northern Australia. *Fusarium* wilt disease of banana is, however, a major production constraint, capable of devastating a variety of banana cultivars. The disease is caused by *Fusarium oxysporum* f. sp. *Cubense*, with several 'races' infecting plants, some being more virulent than others. *Fusarium* spreads by lying dormant in soil for long periods. It cannot be controlled by fungicides, only through effective containment and management strategies. Successful strategies must be based on correct characterisation of *Fusarium* pathogenic forms. This project is undertaking research to help develop national management strategies.

Project progress

First progress report due in 2007.

CP/2006/051: Cocoa pod borer scoping study in PNG

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	CAB International, Malaysia
Project Leader	Dr Wai Hong Loke Phone: 603 89432921 Fax: 603 89436400 Email: loke@cabi.org
Collaborating Institutions	
Project Budget	\$65,000
Project Duration	01/06/2006 to 31/10/2006
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

The Asian Cocoa Pod Borer (CPB), *Conopomorpha cramerella*, is a devastating moth pest of cocoa and the most serious constraint to cocoa production in Southeast Asian cocoa growing countries. Incursion of this pest into PNG was detected at Keravat, East New Britain Province (ENBP) in March 2006. Damage was observed to be very severe (90–100%) in some areas at both LAES and Kareeba Plantation. Cocoa production in PNG is an important activity (economically, socially and environmentally) and a prime pillar of the national economy. The current eradication campaign conducted by the PNG government involves systematic delimiting surveys, rampassen, pruning/pollarding, chemical spraying, halt/restriction of movements (of materials, produce, vehicles, people), etc. There have been both successes and failures in eradication of CPB pest incursions from reports in the literature. In Philippines, Malaysia and Indonesia what were thought to be eradication successes were only temporary and resurgence plus new hot spots flared up later on, indicating that total and permanent eradication is very difficult to achieve.

CABI has personnel with relevant technical expertise and with long, historical and significant track record in managing agricultural invasive alien species (IAS) in cocoa such as the CPB. CABI also have a good network of CABI Associates with relevant CPB/cocoa experiences in CPB management in Malaysia and Indonesia. Additionally, the CABI microbial genetic resource collection and information bank contain materials relevant to cocoa agronomy and pest management which would be useful to current the PNG incursion and future management programmes. The proposed technical visit by the CABI team aims to assist and further build upon the efforts conducted presently to help ascertain eradication and plan future contingency/management programmes.

Project progress

1. This is the report of the ACIAR funded consultancy visit by the CABI team of Drs. Loke Wai Hong, Ho Cheng Tuck and Lim Guan Soon to Papua New Guinea from 7-21 August 2006 for the purpose of supporting management of the cocoa pod borer *Canopomorpha cramerella* incursion in the country.
2. The CABI team worked closely with PNG ACIAR, CCI, NAQIA, NARI and other relevant agencies during the visit.
3. A record was found at the NARI National Agriculture Entomology Collection Centre to substantiate reports in scientific literature of the presence of CPB in PNG in the 1940s–1960s. The reason for the CPB being not subsequently reported in the country until 2006 remains unclear. For ease of reference, CPB activity in PNG in this report will be taken to be incursions.
4. CPB was confirmed to be in cocoa of ENBP on 29 March 2006 and West Sepik in June. Eradication operations have been carried out over a 2000 ha zone of cocoa at ENBP. This is yet to fully commence at West Sepik as at the end of the visit.

5. Eradication procedures at ENBP were opined to be exemplary, with inputs generally matching if not more than those practised in CPB eradication efforts of other countries. There are however great contrasts between conditions at ENBP and West Sepik (e.g., poor access and communications, isolation, discontinuous location and relative neglect of cocoa plantings) and it will be a major challenge to be able to realise all that are planned for the latter.
6. In the light of the overall impressions gained through the visit, prognoses for eradication of CPB depend on three scenarios under which cocoa are grown:

	Prospect of		
	Eradication	Containment	Management
Scenario 1 Pertains to the more organised and accessible cocoa plantings, e.g., plots at CCI, NARI and Kereeba	High	High	High
Scenario 2 Pertains to the smallholders outside of Scenario 1 at ENBP. Plantings are characterised by uneven distribution and difficult terrain	Medium	High	High
Scenario 3 Cocoa grown under the difficult conditions of West Sepik	Low	Medium	Medium

High—Very likely to be achieved

Low—Unlikely to be achieved

Prospect for eradication thus decreases down the continuum from Scenario 1 to 3. Under a best-case situation, the CPB is envisaged to be eradicated at the ENBP incursions with those at West Sepik being contained. This could lead to an eventual situation where PNG could be divided into CPB-free zones with strict inter- and intra-country quarantine measures maintaining the status of such zones. The worse-case scenario would be the failure to eradicate the CPB and the cocoa enterprises of the nation will have to live with and manage the pest. Arrival at the latter situation is strongly indicated should the CPB re-emerge at the Scenario 2 infestations despite the current intense eradication inputs.

7. Immediate follow-up actions outlined in the report by the Emergency Response Unit at ENBP should be implemented. Of these, the following are emphasised:
 - i. CPB awareness and education must be sustained.
 - ii. Institution of a systematic and standardised nation-wide surveillance programme.
 - iii. Surveillance must be multi-tactical in nature

At West Sepik, urgent requirements are:

- i. Improvement of accessibility and communications for emergency response work.
- ii. Increase awareness of the pest to farmers and general populace of the Province.
- iii. Implement multi-tactical surveillance for the pest.
- iv. Setting up of quarantine road blocks.

8. Although it is only logical for the authorities to attempt to eradicate CPB incursions in PNG, the possibility of this being fully realised in the long term is unlikely. It would thus be prudent to prepare the nation towards the prospect of having to manage the pest in its cocoa. Capacity to do this must be built up simultaneously with the current eradication efforts so that there will be no capability gaps when the time comes for the cocoa growers to live with the pest. Priorities for the management of CPB infestations are recommended to be:
 - i. Maintenance pruning, canopy reduction and height control of cocoa.
 - ii. Regular and systematic monitoring.
 - iii. Frequent and complete harvesting.
 - iv. Sanitation.
 - v. Target pod spraying.
 - vi. Use of tolerant/resistant planting materials.

On concern that even the above basic inputs could be hard pressed to be fully implemented on some of the more remote or highly subsistence-level farms, inputs (i), (iii) and (iv) alone are expected to bring about meaningful suppression of CPB damage.

9. The fore-going management inputs, although practical to experienced cocoa growers, would need to be taught to smallholders at all levels. For effective farmer training, the farmer participatory training and research methodology, which centres on discovery learning, is advocated. However, before this can be done, it is necessary for extension workers to be trained. Appropriate capacity building workshops would need to be conducted for this purpose, following which, trained extensions staff can then run training sessions for cocoa farmers. This process is envisaged to require the following:
- i. Training of Master Trainers. Begin by training and nurturing a core group of Master Trainers/Facilitators.
 - ii. Training of Trainers/Facilitators (TOT/TOF). The Master Trainers/Facilitators then conduct TOT to train many more Trainers (or Facilitators).
 - iii. Farmer Training. The Facilitators then conduct farmer training (with 1–2 Facilitators training a group of 30-35 farmers each time).

There is merit in the development of curriculum and trial implementation of such a programme in preparation for possible establishment of CPB in PNG.

10. As there is urgency to develop and validate treatments for containment and management of the pest in the event of failure of eradication, immediate directions of research are recommended to be applied in nature. Priorities are:
- i. Use of tolerant/resistant planting materials.
 - ii. Refinement of CPB monitoring methods.
 - iii. Prospecting for biological control agents.
 - iv. Screening for insecticides and pesticide application technology.
 - v. Demonstration plots.

More basic and long-term research that could benefit the management of CPB in PNG would involve identification of alternative host plants of CPB, molecular determination of CPB biotypes or races together with cross-hybridisation and cross-infestation studies, classical biological control by importation and mass production of parasitoids, development of biopesticides, investigations on other semiochemicals besides pheromones, etc. Such studies would however be more appropriately conducted at a time when continuing management of the CPB becomes a necessity for the PNG cocoa industry.

11. CCI Tavilo and Madang and LAES NARI presently possess the infrastructure to implement the aforementioned CPB management and research. Funding, and where appropriate, specialist collaborations, would however be needed to support their operations and implementation. CABI is capable of and is willing to spearhead an international/Australian team comprising CPB experts, cocoa crop protection scientists, FPTR specialists and experienced project administrators to work in collaboration with and in direct support of PNG institutions.

SFS/2001/068: Technical support for regional plant genetic resources development in the Pacific

Overseas Collaborating Countries	Fiji, Kiribati, Malaysia, Papua New Guinea, Samoa, Solomon Islands, Tuvalu, Vanuatu
Commissioned Organisation	International Plant Genetic Resources Institute, Malaysia
Project Leader	Dr V. Ramanatha Rao Phone: +60 3 89423891 Fax: +60 3 89487655 Email: v.rao@cgiar.org
Collaborating Institutions	Secretariat of the Pacific Community, Fiji
Project Budget	\$933,797
Project Duration	01/01/2002 to 31/12/2006 (Project extended from 01/01/2005 to 31/12/2006)
ACIAR Research Program Manager	Dr Simon Hearn

Project background and objectives

The unique and important diversity maintained in the perennial crop-based production systems of Pacific Island countries is becoming better recognised. In the context of agricultural plant genetic resources (PGR) conservation and use, some collecting, conservation and improvement of PGR (e.g. roots and tubers, bananas, coconuts and breadfruit) has been carried out in the region. This includes the establishment of the Regional Germplasm Centre (RGC) at the Secretariat of the Pacific Community (SPC) and activities funded by the European Union (the EU-funded Pacific Regional Agricultural Programme (PRAP)), INIBAP (the International Network for the Improvement of Banana and Plantain—one of IPGRI's programs), Australia's Department Agriculture, forestry and Fisheries through SPC, and COGENT (the International Coconut Genetic Resources Network, for which IPGRI provides the facilitation unit). More recent and current PGR activities in the region include: the AusAID-funded TaroGen project for the improvement, conservation and utilisation of taro genetic resources; the EU-funded South Pacific Yam Network (SPYN) for collecting and conservation of *Dioscorea alata*; COGENT activities focusing on the collecting of coconut populations from Pacific Island countries and their establishment in the PNG International Coconut Genebank; further breadfruit characterisation; and distribution of INIBAP banana lines resistant to Black Leaf Streak virus.

However, it has been observed that progress has so far been made only with a few crops in a limited number of countries. In view of this, in April 1999, ACIAR supported a workshop in Lae, Papua New Guinea (PNG) in order to develop a framework for PGR conservation, management and use in Pacific agriculture. Following this a PGR Working Group was established, consisting of PNG and Fiji, facilitated by SPC. The working group came together and developed the regional plant genetic resources framework for the Pacific, which was approved by the Permanent Heads of Agricultural and Livestock Services (PHALPS) during its meeting in Fiji in early 2001.

The project is developing complementary conservation strategies (CCS) for agricultural crops of importance in the Pacific Region as a basis for sustainable plant genetic resource (PGR) conservation; including guidelines for the implementation of CCS, and promoting their implementation for high-priority agricultural crops.

Project progress

Year 4 (01/01/2005–31/12/2005)

Ensure effective coordination of PGR activities at regional level in the Pacific

Continued regional coordination and collaboration on PGR issues is essential in the Pacific, where national capacity and resources remain limited and these must therefore be used as efficiently as possible. The Pacific Agricultural Plant Genetic Resources Network (PAPGREN) annual meeting took place in Vanuatu in October 2005, allowing network members to visit the Vanuatu Agricultural Research and Training Centre, where interesting PGR conservation and breeding work is taking place. A major output of the meeting was an agreement on the major points of a regional strategy for the Global Crop Diversity Trust.

The RGC Adviser attended the Banana Asia-Pacific Network (BAPNET) annual meeting. The PGR Adviser attended the annual COGENT meeting, the International Coconut Forum and participated, on behalf of the region, in a meeting at IPGRI, aimed at developing a global project on monitoring genetic erosion. The email alert service PGR News from the Pacific continues to provide information to PGR stakeholders in the Pacific and beyond.

Develop and implement strategies for the effective conservation and use of PGR for food and agriculture in the Pacific (including neglected and underutilised species)

PAPGREN meetings in 2004 and 2005 agreed on the elements of a regional strategy for ex situ conservation, which formed the basis of a submission to the Global Crop Diversity Trust (GCDT) in January 2006. This strategy is based on complementarity of approaches (field genebanks, tissue culture, and cryopreservation), adequate duplication, and effective collaboration among all stakeholders within the region and beyond as necessary. It includes elements of the strategy for taro and breadfruit developed by TaroGen and PAPGREN, thus building on earlier efforts by this project's precursors. Pacific regional strategies for banana and coconut have also been developed for the GCDT with substantial input from the RGC and PGR Advisers in consultation with national programme focal points. A concept note for a Pacific Regional Crop Improvement (PARCIP) programme has been finalised. Specific targeted activities have been supported in participating countries to strengthen conservation of priority PGR:

Bele in Vanuatu. There are two mature core collections in Santo. Peter Kaoh and Oniel (DSAP), Tan Molisale and two students, under DSAP Vanuatu, have been describing the two collections using the NARI descriptor list. In February a larger collection was established at VARTC combining plants from both collections. Peter Kaoh recently flew to Vila with planting materials from the two Santo collections. Plantings are now under way in Tagabe plot—a collaboration with other SPC Teams and projects.

Taveuni taro genebank, Fiji. It was agreed to have the Taveuni Taro Genebank established as an activity in the 'Keep Taveuni Taro Beetle Free' campaign. During the analysis of how the taro beetle could get to Taveuni, stakeholders identified smuggling of varieties from affected areas to Taveuni (an island free of taro beetle) and other non-affected areas as one of the main risk factors. The rationale then was to collect and set up a taro genebank on Taveuni so that farmers would be provided with clean planting materials of the preferred local varieties. These local cultivars are now difficult to find on Taveuni due to the cultivation of the few commercial varieties. Farmers have expressed their keen interest in replanting these local varieties for food security and for meeting traditional obligations such as weddings, funerals etc. About a dozen varieties are currently included in the, locally collected, genebank. Others will be introduced as tissue culture from Koronivia and/or the RGC. This work is a collaboration with other SPC Teams and projects.

Yam genebank in Samoa. The yam collection established and being maintained on- farm by Bill Cable has been characterised using standard descriptor lists (and photographs). A draft catalogue was produced. This work is a collaboration with other SPC Teams and projects.

Genebanks in Kiribati. Genebanks of major traditional crops (breadfruit, pandanus, giant swamp taro) are being established on some outer islands (Araruk, Butaritari, Maraki and Nikunau) to increase access by farmers. This work is also a collaboration with other SPC Teams and projects.

Survey of nut genebanks in Solomon Islands. As a joint SPRIG-SPC-PAPGREN activity, Barry Evans, together with Michael Max of the Department of Agriculture, surveyed the indigenous nut collections he assembled in the 1990s in various research stations in the Solomon Islands. In February 2006, he submitted his draft report summarising the status of the collections and setting out recommendations for their future management. A database of the information on individual trees he collected on this occasion is being put together with older data retrieved from files (many of the original files were destroyed in the Solomon Islands during the recent ethnic tension).

Increase capacity in PGR conservation and use in the Pacific

An important role of the PGR Adviser is to provide training to national staff on PGR issues. This was done during the PAPGREN meeting, where a lengthy session was devoted to the policy issues arising from the ITPGRFA negotiations. The RGC and PGR Advisers also provided lectures and other support to USP's Biodiversity and Conservation course. In addition, the PGR Adviser was a resource person at a meeting of the Agricultural Liaison Officers in Vanuatu in August, which served to heighten the awareness of PGR issues of these key information people. Two people, one from Koronivia Research Station, Fiji and one from NARI, PNG, attended a training course aimed at promoting the use of the LUCID (a software developed by the Centre for Biological Information Technology for interactive identification). It can be used to distinguish species, disease symptoms or varieties of a crop. This software is expected to be extremely useful for managing and analysing PGR characterisation data.

The unique and important diversity maintained in the perennial crop-based production systems of Pacific Island countries is becoming better recognised. In the context of agricultural plant genetic resources (PGR) conservation and use, some collecting, conservation and improvement of PGR (e.g. roots and tubers, bananas, coconuts and breadfruit) has been carried out in the region. This includes the establishment of the Regional Germplasm Centre (RGC) at the Secretariat of the Pacific Community (SPC) and activities funded by the European Union (the EU-funded Pacific Regional Agricultural Programme (PRAP)), INIBAP (the International Network for the Improvement of Banana and Plantain—one of IPGRI's programs), Australia's Department Agriculture, Forestry and Fisheries through SPC, and COGENT (the International Coconut Genetic Resources Network, for which IPGRI provides the facilitation unit). More recent and current PGR activities in the region include: the AusAID-funded TaroGen project for the improvement, conservation and utilisation of taro genetic resources; the EU-funded South Pacific Yam Network (SPYN) for collecting and conservation of *Dioscorea alata*; COGENT activities focusing on the collecting of coconut populations from Pacific Island countries and their establishment in the PNG International Coconut Genebank; further breadfruit characterisation; and distribution of INIBAP banana lines resistant to Black Leaf Streak virus.

However, it has been observed that progress has so far been made only with a few crops in a limited number of countries. In view of this, in April 1999, ACIAR supported a workshop in Lae, Papua New Guinea (PNG) in order to develop a framework for PGR conservation, management and use in Pacific agriculture. Following this a PGR Working Group was established, consisting of PNG and Fiji, facilitated by SPC. The working group came together and developed the regional plant genetic resources framework for the Pacific, which was approved by the Permanent Heads of Agricultural and Livestock Services (PHALPS) during its meeting in Fiji in early 2001.

The project is developing complementary conservation strategies (CCS) for agricultural crops of importance in the Pacific Region as a basis for sustainable plant genetic resource (PGR) conservation; including guidelines for the implementation of CCS, and promoting their implementation for high-priority agricultural crops.

Concluded projects

1 July 2005–30 June 2006

Bilateral

AH/2000/009	Development of diagnostic and control methodologies for animal trypanosomiasis (Surra) in Papua New Guinea, Indonesia, the Philippines and Australia	97
ASEM/2001/055	Improving yield and economic viability of peanut production in Papua New Guinea and Australia using integrated management and modelling approaches	99
CP/1996/140	Biological threats to <i>Saccharum</i> germplasm and sugar production in Papua New Guinea, Indonesia and Australia	101
CP/2001/032	Impact and management of <i>Oribius</i> weevils in Papua New Guinea	103
FIS/2005/022	Cross-institutional exchange. Work placement at the Highlands Aquaculture Extension and Development Centre (HAQDEC), Aiyura, Eastern Highlands Province, PNG	105
FIS/2005/026	SPC support for ACIAR Seaweed Marketing Consultancy	107
FST/1998/113	Development of a sustainable, community-based essential oil industry in the Western Province of Papua New Guinea using the region's woody-plant species	109
FST/1998/118	Planning methods for sustainable management of timber stocks in Papua New Guinea, s forests	111
FST/2002/010	Domestication and commercialisation of multi-purpose indigenous trees and shrubs for food and other products in Papua New Guinea, the Solomon Islands and Queensland: a feasibility study with special reference to <i>Canarium</i> nut	113
FST/2005/049	<i>Mastotermes</i> scoping study in PNG	116
FST/2005/050	PNG agroforestry systems—scoping study	118
HORT/1998/061	Coconut tissue culture for clonal propagation and safe germplasm exchange	120
LPS/2001/077	Poultry feeding systems in PNG	122
SMCN/2005/043	Analysis of biophysical and socio-economic constraints to soil fertility management in the PNG Highlands	124

Multilateral

FIS/1999/025	Optimal release strategies for restocking and stock enhancement of the tropical sea cucumber, sandfish (<i>Holothuria scabra</i>)	127
--------------	---	-----

AH/2000/009: Development of diagnostic and control methodologies for animal trypanosomiasis (Surra) in Papua New Guinea, Indonesia, the Philippines and Australia

Overseas Collaborating Countries	Indonesia, Papua New Guinea, Philippines
Commissioned Organisation	Murdoch University, Division of Veterinary and Biomedical Sciences, Australia
Project Leader	Dr Simon Reid Phone: 08 9360 7423 Fax: 08 9310 4144 Email: s.reid@murdoch.edu.au
Collaborating Institutions	Research Institute for Veterinary Science, Indonesia Dinas Peternakan, Irian Jaya, Indonesia National Agriculture Quarantine and Inspection Authority, Papua New Guinea University of Southern Mindanao, Philippines Department of Agriculture, Region XI, Philippines Balai Penyidikan Penyakit, Sulawesi, Indonesia University of Western Sydney, Australia
Project Budget	\$600,002
Project Duration	01/01/2001 to 31/12/2005 (Project extended from 01/01/2004 to 31/12/2005)
ACIAR Research Program Manager	Dr Peter Rolfe

Project background and objectives

The disease of animal trypanosomiasis (or surra) is caused by the protozoan parasite *Trypanosoma evansi*, transmitted by biting tabanid flies (March flies). The result of infection is an acute or chronic wasting, depending on host susceptibility and the virulence of the parasite strain. Many animals can be afflicted, including livestock and horses. The disease is found in much of the world, including all of the Philippines and Indonesia. Evidence from antibodies in blood samples shows that *T. evansi* may be present in parts of Irian Jaya. However, it is believed that Australia and Papua New Guinea may no longer be free of this disease.

Recent research has shown that pigs and deer could be efficient reservoir hosts for the parasite. Pigs and two species of wallaby common to Papua New Guinea and northern Australia are believed to be highly susceptible to infection and suffer acute disease with a high mortality rate. Therefore if the disease is found in PNG or enters Australia, it would have a devastating effect on livestock and probably on many native marsupials.

Before any control programs could be designed, more knowledge was needed about the impact of *T. evansi* on livestock and the determinants of clinical disease. This would require sensitive and well-validated diagnostics tests, coupled with an understanding of the genetics of virulence in the different strains of *T. evansi*. To date there were no such effective tests, and drugs used in treatment had not been systematically evaluated.

Both Indonesia and the Philippines wanted to establish control mechanisms to reduce livestock infection and improve productivity. This project therefore involved both countries, along with Papua New Guinea and Australia, building on earlier research into the parasite carried out at James Cook University, Townsville (ACIAR project AS1/1996/150) that demonstrated the inadequacy of existing diagnostic tests.

The project aimed to develop accurate diagnostic tests for this parasitic disease, to establish more effective ways of controlling it, and to transfer this technology to neighbouring countries to improve surveillance and reduce the risk of disease entry to Australia.

Project outcomes

The project's main scientific achievement is a considerably enhanced capability for effective surveillance of Surra in Irian Jaya, PNG and the Philippines. A network of researchers on *T. evansi* from Indonesia, the Philippines, Australia, PNG and external agencies such as ILRI is now firmly established.

The successful outcomes were achieved by the transfer of current diagnostic technologies which were then improved by identifying more specific and sensitive tests for serological diagnosis. The scientists developed molecular techniques for low-level detection of organisms in blood samples, identified genetic markers for pathogenicity of *T. evansi* and tested their usefulness in predicting outbreaks of clinical disease. They also investigated the efficacy of existing trypanocidal drugs for the treatment of *T. evansi*. The elucidation of the epidemiology of infection with *T. evansi* in Mindanao and Sulawesi was a significant and important contribution to understanding the disease in Asia. A secondary, vital achievement was development of techniques to collect and send blood and tissue samples to Australia in compliance with Australian quarantine standards.

The research to date suggests there are multiple factors involved in the development of outbreaks of Surra in the Philippines. The severity of outbreaks of Surra in Mindanao could be due in part to genetic differences compared to Indonesian isolates, and preliminary results using the mouse pathogenicity test suggest this. Pathogenic strains of *T. evansi* were identified in specific areas, indicating that control programs must focus on regions where acute clinical disease is most likely and that the response to notifications of clinical disease must be rapid to prevent death due to infection.

Further technology transfers to participating countries should improve the effectiveness of surveillance for *T. evansi*. The information gathered can then be incorporated into guidelines on the most cost-effective treatments of infection with *T. evansi*. This should improve the success of treatment and control programs based on treatment of infected animals.

ASEM/2001/055: Improving yield and economic viability of peanut production in Papua New Guinea and Australia using integrated management and modelling approaches

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Australia
Project Leader	Dr Rao C N Rachaputi Phone: 07 4160 0737 Fax: 07 4162 3238 Email: rao.rachaputi@dpi.qld.gov.au
Project Web Site	http://www.dpi.qld.gov.au/fsi/4354.html http://www.dpi.qld.gov.au/fieldcrops/3027.html http://www.dpi.qld.gov.au/fieldcrops/6548.html
Collaborating Institutions	Trukai Industries, Papua New Guinea National Agricultural Research Institute, Papua New Guinea International Crops Research Institute for the Semi Arid Tropics, India Ramu Sugar Ltd, Papua New Guinea
Project Budget	\$593,037
Project Duration	01/07/2002 to 31/12/2005 (Project extended from 01/07/2005 to 31/12/2005)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Peanut production used to be an important industry in Papua New Guinea (PNG). Production for commercial processing and for export has declined since the late 1980s with the lack of high-yielding varieties, seed supply and cost-effective practices suited to local farming systems all factors. Aflatoxin, a potential health problem, is another as consumption of raw peanuts is common. There is little information on the incidence and extent of contamination of peanuts with aflatoxin in PNG, but studies from similar environments in Indonesia suggest that aflatoxin is likely to be a major problem.

Australia also has some common issues such as drought and aflatoxin contamination—although the peanut industry is more developed than PNG. Australian peanut growers have expressed a need for an economic support package that could help them to make critical decisions about farm management and financial planning. The modelling systems available focus on crop production risks and do not currently incorporate whole farm economic risks. In India, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has a peanut breeding program to produce high-yielding varieties with desirable characteristics, such as large kernel size and tolerance to foliar diseases, for use in developing countries.

The project is developing sustainable practices to improve the yield, quality and economic viability of peanut production in PNG and Australia. This will be achieved by gathering information on peanut production, storage, use, marketing and aflatoxin contamination in PNG, and by developing economics management software for the Australian peanut industry. ICRISAT will participate in the project's activities in PNG.

Project outcomes

A peanut farmer survey conducted in four major peanut-growing regions, i.e. Eastern Highlands Province (Highlands), Markham Valley (Dry Lowlands), National Capital District (NCD-Dry Lowlands and Peri-Urban) and East New Britain Province (Wet Lowlands), assessed the status of peanut production, postharvest storage, utilisation, marketing systems and the extent of aflatoxin contamination. It revealed that peanuts play a significant role in increasing individual household incomes, thus contributing to living standards of the farming communities.

Peanut ranked amongst the top five income-generating crops across all the survey regions. It is estimated that about 60 percent of PNG farming families or households in the surveyed areas grew peanuts over an estimated land area of 14,000 hectares. The production estimate of 12,600 tonnes earned a gross income of around 30 million kina.

As part of the survey, a total of 274 peanut samples were collected from four major road side markets in the surveyed regions and analysed for aflatoxin content. Aflatoxin contamination was found in all the four markets with the percentage of positive samples being 22% in the Morobe Province, 35% in the East New Britain Province, 16% in NCD and 12% in the Eastern Highlands Province. Although >80% of samples recorded less than 20 ppb, 5% of the samples contained unacceptable levels of aflatoxin (up to 1000 ppb). Higher levels of contamination were often present in the roasted and dry pod samples. Combining results of the aflatoxin survey with the APSIM modelling work conducted in the project enabled the project team to draw some conclusions and make recommendations for future work related to aflatoxin minimisation in PNG.

A total of 47 improved lines of peanuts, consisting of short- and medium-duration varieties with foliar disease resistance and large kernel characteristics, were introduced from ICRISAT, India in 2002. The field trials resulted in identification of promising varieties with significant yield advantage over local checks. However, a large genotype x environment interaction observed in the trials meant that the varietal releases may have to be specific to each region. The selected varieties are being further evaluated on farmers fields to assess their local adaptation before releasing for general cultivation. The APSIM peanut model was validated using the yield data from field trials and daily climate records of Aiyura, Bubia and Ramu Sugar sites. The model predicted pod yield satisfactorily for Bubia and Ramu Sugar sites but poorly for Aiyura site, due to unknown site-specific constraints. The analysis also suggested peanut crops sown between April and June at Ramu Sugar are more likely to experience dry weather, consequently, low yields and increased risk of pre-harvest aflatoxin contamination.

The project developed a 'beta' version of the economic modelling software package 'SmartPeanut', which is a suite of software tools that combines an economic framework and crop simulation models to analyse farming systems as an investment. Applications of 'SmartPeanut' include comparing economic risks and opportunities of various crop rotations, investments on new farm machinery, options to improve economic viability of the enterprise in relation to resources such as farm size, leasing versus owning land/machinery etc. 'SmartPeanut' will also be useful for researchers and consultants in studying the impact of climate and agronomic practices on farm sustainability and profits.

Adoption of project outcomes

A hands-on workshop on 'SmartPeanut' was held at Kingaroy, following which the SmartPeanut package CD was distributed to selected peanut growers, consulting agronomists and processors for evaluation. In the extension phase of the project, a strategy for seed multiplication was put in place at the Ramu Sugar site to facilitate supply of the seed of promising varieties for use in the on-farm trials. A pest and disease survey of peanut crops in Morobe and Eastern High Land Provinces was implemented and a comprehensive survey report completed. A peanut market supply-demand survey was conducted by NARI to assess relationships between demand, supply and price of peanuts in the PNG domestic market and assess the reaction of peanut growers and consumers to possible future changes in demand and price of peanut.

A preliminary study on satellite imagery of the northern Markham Valley in PNG showed there is good potential for application of the satellite and Near Infra Red (NIR) remote sensing technology to assess regional peanut production in PNG. Similarly in Australia a combination of satellite and aerial infra-red imagery in conjunction with change detection software techniques showed potential for its application to identify high aflatoxin risk zones which growers can then use to segregate harvest areas and maximise gross returns.

CP/1996/140: Biological threats to *Saccharum* germplasm and sugar production in Papua New Guinea, Indonesia and Australia

Overseas Collaborating Countries	Indonesia, Papua New Guinea
Commissioned Organisation	Bureau of Sugar Experiment Stations, Australia
Project Leader	Dr Robert Magarey Phone: 07 4068 1488 Fax: 07 4068 1907 Email: rmagarey@bses.org.au
Collaborating Institutions	Indonesian Sugar Research Institute, Indonesia Ramu Sugar Ltd, Papua New Guinea Australian Quarantine Inspection Service, Australia Institute of Arable Crops Research, UK
Project Budget	\$1,000,563
Project Duration	01/07/2000 to 30/06/2006 (Project extended from 01/07/2004 to 30/06/2006)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Sugar cane (*Saccharum* species) is an important tropical crop both in Australia and in the wider region. The centre of origin of the genus is the island of New Guinea, which contains a rich diversity of germplasm.

Several serious diseases and pests of *Saccharum* occur in Irian Jaya and Papua New Guinea but not in the rest of Indonesia or in Australia. Conversely, some diseases occur elsewhere but not in Irian Jaya or Papua New Guinea. The various pests and diseases pose a great threat to commercial sugar production in all three countries, and especially worrying is their movement into new areas. Knowledge of the distribution of the pathogens and pests is still very scant and, in some cases, so are the details of their ecology.

The germplasm within the island of New Guinea is likely to be useful in counteracting the problems faced by commercial growers, as long as it can be used without bringing its pathogens with it. At an international conference on sugarcane quarantine and germplasm exchange in Brisbane in 1995, it was agreed that research was urgently needed on conserving *Saccharum* germplasm and on minimising the threats from its pests and diseases—which would include increased awareness and more effective methods of quarantine.

This project will therefore survey the distribution of pathogens and pests across the region, research the ecology and possible control measures for these biological threats, and provide the necessary lab equipment and training to improve research skills and quarantine operations in the region.

The aim of the project was to study the pests and diseases of sugar cane, and improve quarantine operations and the skills of researchers and quarantine officers in Australia, Indonesia and Papua New Guinea.

Project outcomes

Regional surveys revealed significant new information about pest and disease distribution. For example, spread of hybrid material is leading to disease spread and loss of *S. officinarum* germplasm in PNG, Indonesia and Torres Strait Islands.

Variety selection trials showed that there are differences between varieties in susceptibility to shoot borer infestation; a number of varieties have been identified as standards (resistant and susceptible) in these trials and these will be used in future work.

The screening program has screened over 1000 clones for resistance to sugarcane smut and a high percentage of Australian clones were found to be susceptible to the disease.

Diseased leaves were imported through quarantine from Ramu Sugar into Australia for molecular assay work to develop a sensitive assay for the disease Ramu stunt for use in germplasm exchange.

Workshops were held in PNG, Torres Strait Islands and Indonesia to train quarantine staff. The first PNG sugarcane pest and disease manual, with photos and text, was produced and distributed to personnel at the PNG workshop. This will enable quarantine staff and others to become acquainted with sugarcane pest and disease issues. A similar manual was produced for Australian quarantine staff in the Torres Strait. Posters were produced in English, Motu and Pidgin to highlight quarantine issues in PNG.

The incidence of unknown forms of sugarcane mosaic virus in Indonesia and PNG were noted during the regional surveys.

CP/2001/032: Impact and management of *Oribius* weevils in Papua New Guinea

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Queensland University of Technology, Australia
Project Leader	Dr Anthony Clarke Phone: 07 3864 5023 Fax: 07 3864 1535 Email: a.clarke@qut.edu.au
Collaborating Institutions	National Agricultural Research Institute, Agricultural Research Division, Papua New Guinea Fresh Produce Development Company Ltd., Crop Protection Programme, Papua New Guinea
Project Budget	\$486,003
Project Duration	01/07/2002 to 30/04/2006 (Project extended from 01/01/2005 to 30/04/2006)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Oribius weevils occur in Papua New Guinea, Irian Jaya and far north Queensland. They are a major agricultural pest in PNG, attacking the leaves, young shoots and developing fruits of a wide range of crop plants. Loss of plant vigour and surface scarring of fresh produce can reduce crop yields by 50–100 per cent.

At present there is almost no information on *Oribius* weevils. It is known that adults rather than larvae cause the damage to plants, but little is known about their status, systematics or ecology.

The project is estimating the impact of *Oribius* weevils on fruit and vegetable crops in Papua New Guinea (PNG), by obtaining information on *Oribius* systematics and ecology, to help develop methods to control infestations of these weevils.

Project outcomes

Nearly all Highlands' crops were found to suffer at least some oribius damage and the project team considered that the impact of the weevil was underestimated

Biological impact surveys were carried out for avocado, cabbage, capsicum, citrus coffee and strawberry. In all trials oribius management reduced damage significantly, with yield from protected plots up to 10 times greater than from unprotected plots. Coffee bean yield was not significantly affected by oribius, but oribius feeding did affect the growth of coffee seedlings and coffee regrowth after pruning. An extensive farmer-based crop impact survey was also undertaken. Twenty-four commonly grown crops were surveyed, based on a relative damage scale (high, medium and low). Only three crops (carrot, spring onion & asparagus) always scored as low damage, while 15 crops were reported as having some level of high damage. Based on their extensive and intensive research, the project scientists deemed *Oribius* to be the most serious pest of agriculture in the PNG Highlands.

Five insecticides were lab tested on both *O. destructor* and *O. inimicus*. Karate, Target and Chlophyrifos had the highest efficacy, whilst Orthene and Malathion were significantly less effective. Direct spraying of insecticide onto weevils was the most efficient exposure technique. There was no apparent difference in the efficacy of insecticides based on *Oribius* species. The three most effective insecticides were subsequently further tested at one-half and one-quarter manufacturers' recommended concentration. Karate and Target were still highly efficacious at the lower dosages.

A simple cost:benefit analysis was undertaken on insecticide control techniques, and results indicated that treatments to control oribius were highly profitable, with ¼ strength Karate control yielding a K66.40 increase in return compared with no control of oribius.

Soil-dwelling larval stages were confirmed to feed on the roots of selected plant species. The flightless adult beetles walk onto host plants where they feed and mate: it appears that beetle movement between host plants is common. At Aiyura and Goroka adults can be found in the field all year round, but are most abundant between November and April.

Oribius weevils feed on a very large number of different crop and non-crop plants, but they do not utilise all plants equally. In a survey of 32 of the most common crop and weed plants around the Aiyura Valley, *O. inimicus* was collected from all but one plant species (spring onion), with 34% of beetles collected from only three plant species (pepino, guava and thickhead). For *O. destructor*, the second most common *Oribius* species at Aiyura, seven of the surveyed plant species yielded no beetles, while the three most commonly utilised hosts, yielding 41% of individuals, were pepino (again), cassia and poinsettia.

OB Nothing has been published on the taxonomy of the genus *Oribius* since 1959 and the exact number of species in the genus remains unclear. However, the project team estimated there were probably a minimum of 50 species in the genus. Following collation of existing collections, plus new collections, seven *Oribius* species were identified as pests of PNG horticulture. The diagnostic features and distribution of each of these species were recognised and may be available to users via a poster, paper and technical document.

Based on all components of the study the project team made the following recommendations for control.

1. Where oribius damage is quantitatively assessed as medium to high, then chemical control is warranted.
2. Crops should be watched for damage, most closely from December through to June, when beetle numbers are highest.
3. Karate, followed by Target, are the preferred chemicals for control. Application at ¼–½ manufacturer's recommended rates is as efficacious as applying at full rate.
4. Spraying will be most efficient if carried out in the morning (before 10.00 am) or mid-afternoon as beetles are on plants at this time: during the middle of the day they rest in protected areas off the crop. Early morning spraying during peak flowering period of a crop should be restricted as pollinators are also commonly active at this time.
5. Thickhead should be removed from gardens wherever possible because it will attract beetles.

Intercropping or border planting with non-preferred plants, such as spring onion and carrot is likely to reduce oribius damage.

FIS/2005/022: Cross-institutional exchange. Work placement at the Highlands Aquaculture Extension and Development Centre (HAQDEC), Aiyura, Eastern Highlands Province, PNG

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Australia
Project Leader	Mr Brett Herbert Phone: 07 40929913 Fax: 07 40933903 Email: brett.herbert@dpi.qld.gov.au
Collaborating Institutions	
Project Budget	\$68,424
Project Duration	01/06/2004 to 31/12/2005 (Project extended from 01/07/2005 to 31/12/2005)
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

In the Upper Fly region of Papua New Guinea, in contrast to the Eastern Highlands and other provinces where fish farming based on introduced carp, tilapia and trout species has increased dramatically over the last few decades, the introduction of exotic fish species for farming has not been encouraged, for environmental reasons. The Ok Tedi Mining Ltd Livelihood Programs Department, National Fisheries Authority, and local pond owners have all indicated a desire to trial the culture of native species. This project builds on techniques and technologies developed by Queensland Department of Primary Industries and Fisheries in production of native freshwater fishes, with an initial focus on breeding and fingerling production techniques for sooty grunter.

Project outcomes

Breeding and fingerling production techniques as used in Australia were found to be possible in PNG, although logistical issues and identification of spawning aggregations, stocks and seasons make reliable collection of ripe broodstock from the field difficult. This indicated a requirement to maintain broodstock for spawning in ponds. Additionally, low-flow conditions delayed commencement of the project, and then high water conditions delayed fish assessment in the wild. Sooty grunter broodstock were collected from sites near Kiunga, and approximately 40 are now held in ponds, after transport and handling methods were improved to ensure survival during transport. Foods provided to broodstock initially were not conducive to promoting egg development in females and management procedures were changed dramatically, resulting in better condition of broodstock. After broodstock were moved to ponds free of carp and tilapia, and fed better quality foods, their condition improved. However, this was done too late to permit maturation in ponds, and consequently spawning trials were not successful.

OTML staff participated in an exchange in Australia where they spawned sooty grunter (after assessing spawning condition), assessed egg quality, counted and handled fry, collected broodstock, assessed disease issues and learnt fingerling production techniques applicable in the PNG situation. They successfully raised sooty grunter fingerlings and transported them for stocking. They saw sleepy cod spawns (natural spawning) and assisted in catfish (*Neosilurus*) spawning trials and rearing catfish eggs. This exchange built confidence and introduced some of the differences in spawning native fish compared to breeding carp and tilapia. Techniques for production and handling of redclaw crayfish were also learnt, and the high potential of redclaw for PNG aquaculture realised by the OTML staff

Pond and broodstock management principles, critical for native fish spawning, were also developed and practiced in ponds near Tabubil. A hatchery was designed and construction started in Tabubil, and materials required supplied and installed. Aeration, spawning and hatching tanks, water testing equipment and hatchery equipment were all supplied and are ready to use when the hatchery is completed. Ponds have also been built at Tabubil but require a reliable water supply, which is under negotiation. Hatcheries at Tabubil and Kiunga are expected to be operational by mid 2006.

Socio-economic research was limited by logistical and time constraints, but in all areas of the North Fly fish protein (and animal protein in general) was found to be extremely limited. Investigations of local streams found heavy fishing pressure for small rainbow fish and rarity of crustaceans, with very limited standing crops. Fish farms have been established with assistance via OTML and provincial fisheries officers but the main method of transfer of knowledge was from farmer to farmer. While written material is available, it appears that word or mouth and model farms are the best means of extension. OTML uses the village motivator program for training, which works exceedingly well in introducing new crops and methods.

Existing fish farmers breed their own fish (carp, followed by tilapia introduced in 2004) and sell these to new farmers. Advice given during the exchange resulted in improvements in pond design and management in farms, reduced water exchange, fertilisation using local materials, and promotion of natural productivity (algae). Fish farmers were raising carp and achieving prices of up to K20 per kilo for whole fish, earning up to K1500 per pond per year. The more enterprising fish farmers used this money to fund other business developments.

Assessment of the impact of fish farming was that it could be highly beneficial in improving food security and availability of animal protein, as well as providing a source of cash income to pay for school fees, and assist in establishing other business ventures. Certainly the market for fish produced locally was found to be lucrative and large, with all sales of fish being immediate and in many cases, pre-sold. The people purchase and eat fish of almost any size. In adjacent areas (Telefomin and Oksapmin), local markets have absorbed all production from rapidly expanding fish farming.

The interest generated by this activity has opened further opportunities for co-operation, particularly larger scale co-operation with OTML and the Western province which is building a hatchery at Kiunga, primarily for native fish species. Opportunities beyond the scope of this project were identified for a number of native species, particularly freshwater crayfish (*Cherax quadricarinatus*), grease fish (*Neosilurus* spp.) and Fly River herrings (*Nematolosa* and *Clupeoides* spp.). The Sustainable Development Program has a vast portfolio of funds to invest in development and is aware of the potential of aquaculture as a direct result of this project. Provincial Fisheries officers are also keen to be involved in training and extension regarding native fish. The NFA has identified freshwater crayfish in particular as having extremely high potential for a massive impact on protein consumption levels in the highlands regions where it is most needed. A follow-up ACIAR project involving OTML, NFA, and Western Province is under development.

FIS/2005/026: SPC support for ACIAR seaweed marketing consultancy

Overseas Collaborating Countries	Fiji, Kiribati, Papua New Guinea, Solomon Islands, Vanuatu
Commissioned Organisation	Secretariat of the Pacific Community, New Caledonia
Project Leader	Mr Ben Ponia Phone: 687 260166 Fax: 687 263818 Email: benp@spc.int
Collaborating Institutions	
Project Budget	\$16,481
Project Duration	01/06/2005 to 31/07/2005
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

The aim of project is to identify and evaluate marketing constraints and opportunities for seaweed in selected Pacific Island countries. This includes considering options for bilateral cooperation in the marketing and processing of cultivated *Kappaphycus* with aim to improve profitability and sustainability. This may be achieved through establishing national focal points with governments of key countries, effectively communicating project intentions and linkages with key countries, facilitating country consultations with industry players and facilitating regional meetings to analyse reports and formulate regional strategies.

The objectives of the project were as follows.

1. to more clearly identify and evaluate marketing constraints and opportunities for seaweed in selected Pacific Island countries, including consideration of options for regional cooperation in marketing and processing.
2. to examine the production, processing, transportation and marketing options for the cultivated *Kappaphycus* industry in selected countries of the Pacific Community region, with a view to improving profitability and sustainability.

Project outcomes

The countries covered by the study were Fiji, Kiribati, Solomon Islands and Vanuatu. Originally Papua New Guinea was included but that country decided to lower its priority for commencing seaweed farming and withdrew from the project.

This report gives details of the current supply and demand for *Kappaphycus* and the reasons for its positive future potential. As a result of information gathered from country representatives and the visits that followed to the three seaweed-producing countries (Fiji, Kiribati, Solomon Islands) it became apparent that the quantities of seaweed being produced were too small to consider any regional cooperation in marketing and processing. The priority for all countries must be to increase production. Total annual world production of dried *Kappaphycus* is about 220,000 tonnes. Production for the Pacific Islands for 2005 is expected to be about dried 1150 tonnes (0.5% of world production). This would need to increase to at least 5000 t dried (preferably 10,000 t, 5% of world production) before regional cooperation in marketing could be considered. Because of shipping costs between the islands, it would be uneconomic to ship dried seaweed from individual countries to one central island hub for export to buyers. Regional cooperation might be possible—by establishing a regional marketing authority that dealt with all buyers and directed shipments to be sent as required from individual countries direct to buyers.

However even when regional annual production reaches 5000 t, regional cooperation in marketing may not be agreeable to all producing countries. In Kiribati the industry is government controlled, in Fiji the government plans to pass control to the private sector once production is firmly established, in Solomon Islands all marketing is being done by the private sector. Private sector companies that spend time and money developing markets and clients may see little advantage in surrendering their autonomy to a regional organisation. It may depend on market conditions when regional production reaches the suggested 3–5% of world production.

Processing of seaweed within the region was the subject of a study sponsored by Kiribati. The conclusion reached was that a regional annual production of 10,000 t dried of *Kappaphycus* would be necessary to support a plant for the production of semi-refined carrageenan (SRC) and that such a plant must be located in an area where sufficient quantities of water were available (which excluded Kiribati). However since then the SEAPlantNet project has commenced trials into small scale production of SRC chips using minimal quantities of water, at sites near the seaweed-farming areas. [SEAPlantNet, is an initiative of the International Finance Corporation's Program for Eastern Indonesia SME Assistance (IFC-PENSA)]. Development of such a process would allow individual Pacific Island countries to do their own part-processing and export value-added chips, with 25% of the weight and a smaller volume compared to dried seaweed.

When the country reports and country visits showed that regional cooperation in marketing was currently not feasible, it was decided to replace the proposed sub-regional workshop on marketing with one that would promote cooperation in production. This workshop, held in Nadi, Fiji, resulted in useful discussions between farming representatives from four countries, who resolved to continue communication and cooperation on all matters relating to seaweed farming.

FST/1998/113: Development of a sustainable, community-based essential oil industry in the Western Province of Papua New Guinea using the region's woody-plant species

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Dr John Doran Phone: 02 6281 8319 Fax: 02 6281 8312 Email: john.doran@csiro.au http://www.ffp.csiro.au/
Project Web Site	http://www.ffp.csiro.au/
Collaborating Institutions	North Queensland Essential Oils Co-operative Association Ltd, Australia University of New South Wales, Australia University of Papua New Guinea, Papua New Guinea Papua New Guinea Forest Authority, Papua New Guinea James Cook University, Australia G R Davis Pty Ltd, Australia Queensland Department of Primary Industries and Fisheries, Australia
Project Budget	\$675,417
Project Duration	01/01/2000 to 31/12/2005 (Project extended from 01/01/2003 to 31/12/2005)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

In 1994 CSIRO's Australian Tree Seed Centre assisted villagers in PNG's Western Province to start production of essential oils from a local tree. The oil used is similar in its chemistry and potential medical uses to eucalyptus or tea tree oil. It has a ready market locally, and other villages have taken up production.

The fledgling oil extraction industry is poised to become a more valuable village-based enterprise. Such cash-generating activities are sorely needed in remote Western Province. Previous attempts to generate cash—such as rubber, rice, deer and crocodile farming—have foundered. Leaf oil production, however, is smaller in scale, community-based and, crucially, has been requested by the villagers themselves, who have heard of relatives in Irian Jaya carrying out similar activities.

The purpose of the project was to facilitate the development of a sustainable, community-based, economically viable industry for extracting volatile plant oils in Western Province, PNG.

Project outcomes

Project scientists overcame enormous difficulties to achieve significant progress. They showed that oil of acceptable commercial quality could be produced from local raw materials. There were significant areas to source raw materials but the distances could be quite far for manual transport to villages. Researchers identified three species with commercial oil producing potential. The villagers preferred to harvest *Asteromyrtus symphyocarpa* as the yield is double that of *Melaleuca quinquenervia*. In addition, sandalwood was identified in the region, and its oil found to be high quality. A subspecies of *M. cajuputi* (ssp. *platyphylla*) contained oil high in platyphyllol—a compound with potential as a sunscreen and also known to have insecticidal properties.

The project assessed the sustainability aspects of village-based essential oil production. Researchers studied social issues, assessed resources and analysed environmental, economic, technical and information dissemination factors. Attempts to form management committees for oil production met with mixed success, as increasing returns from oil sales exacerbated long-term clan rivalry. Further input from a socio-economist is required to indicate directions for conflict resolution.

Mapping of the extent of resources of the prime oil-producing species using Geographic Information Systems (GIS) with ground verification and collection of quantitative data brought mixed results, due to the difficulty in securing a cloud-free satellite scene.

In 2000, research plots of *A. symphyocarpa* were established to help identify best practice for sustainable harvesting of this species for oil. Results indicated that a light harvesting regime is the most appropriate for long-term sustainability. Fire damage could be a problem.

Technical aspects of oil production were addressed, with the upgrading of all stills. A marketing study concluded that a bulk oil market (for distribution and sale within PNG) could achieve economic sustainability for this industry. A meeting of oil producers in October 2001 voted unanimously to adopt this proposal, which largely replaced the existing trade in small bottles of oil. Medicinal oil distilled from *A. symphyocarpa* is now being marketed in pharmacies in PNG under its local name of Waria-Waria oil.

In northern Queensland nutrition trials for *M. alternifolia* were established in November 2000; optimum levels of nitrogen, phosphorus and potassium were identified, resulting in a 50% increase in growth over controls for the highest application. Trials undertaken to investigate other essential oil species as an alternative to *M. alternifolia* revealed that nerolidol-rich *M. quinquenervia* and the lemon-scented *Eucalyptus staigeriana* were good candidates for further work.

A study of the extent and effect of selfing (self pollinated trees) in controlled crosses (without emasculation) of *M. alternifolia* gave immediate benefit to an Australian Tea Tree Breeding Project, which now has the DNA technology to fingerprint clones, eliminate 'rogues' from the breeding arboreta and identify in progeny trials 'selfs' that usually have reduced growth.

FST/1998/118: Planning methods for sustainable management of timber stocks in Papua New Guinea's forests

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Bureau of Rural Sciences, Australia
Project Leader	Professor Rod Keenan Phone: 03 5321 4124 Fax: 03 5321 4166 Email: rkeenan@unimelb.edu.au http://www.ffp.csiro.au/tigr/atscmain/
Project Web Site	
Collaborating Institutions	Papua New Guinea Forest Research Institute, Papua New Guinea Southern Cross University, Australia Queensland Forest Research Institute, Australia Australian National University, Australia
Project Budget	\$842,009
Project Duration	01/07/2001 to 30/09/2005 (Project extended from 01/07/2003 to 30/09/2005)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Papua New Guinea has over 28 million hectares of tropical forests. These forests play an important role in the conservation of tropical biodiversity and in the livelihood and development of rural and forest dwelling communities. Up to 40% of PNG forests are considered exploitable for timber production with current technology.

There has been a rapid growth of forest harvesting and log export since the 1980s and this has led to major policy reforms in PNG. However, plans on how to use forest resources remain rudimentary and the implementation of policy reforms has been difficult. Consequently, there has been over-cutting of forests, depletion of resources, a heavy environmental impact, and a long-term impact on the future of forest-dependent communities.

For policy and regulatory reforms to be effective, these need to be underpinned by improved planning systems that will integrate national and regional conservation, customary owners, forest companies and small-scale users of forests.

The goal of this project is to assist Papua New Guinea (PNG) to better manage its native forest resources through the introduction of improved technology and through the enhancement of its scientific, technical and management capacity. The project will use technology, planning experience, and management techniques that have been developed for Australian native forests and adapt these to areas that are typical of PNG forests.

Much of the methodology that will be developed in this project can also be applied to the calculation of carbon stocks.

Project outcomes

This project resulted in increased capacity and knowledge within the PNG government for forest planning and inventory, and improved systems to analyse alternative options for timber harvesting. Key outputs included:

1. A major review of forest area assessment, inventory and planning systems used in PNG.
2. Re-measurement of 32 large permanent sample plots in cut-over native forests across PNG. Data from these plots have been used to assess the response of forests to harvesting and to develop new functions for a forest growth model. This information is being used to inform policy decisions on the future use of forests in PNG. The data management system for PSPs was revised and updated.
3. Growth model analysis, which suggests that the 35-year cutting cycle in place in PNG is probably too short to allow for commercially viable future harvests if all trees greater than 50 cm DBH are cut. Longer cutting cycles, higher diameter limits for species that can reach larger sizes, leaving a proportion of current commercial trees for future harvest and reducing harvest impact will provide for more economically and ecologically sustainable timber harvesting.
4. An analysis that compared timber volumes assessed in forest inventory with actual harvest volumes—to determine the cause of differences between these. This kind of analysis is now being applied more widely, to develop estimates of timber resources that more closely reflect industry harvest performance and more realistic estimates of future yield and annual allowable cut.
5. A revised strategic forest inventory method that will result in cheaper and more accurate inventories of future project areas.
6. A simple system to integrate existing forest area, inventory and growth information. This system produces more reliable estimates of future timber yield under different harvesting scenarios for incorporation into forest planning and project documents.
7. More capable and trained staff in the PNG Forest Authority, Forest Research Institute and the Department of Environment and Conservation, who are able to undertake improved analysis of forest inventory information and forest management options.

FST/2002/010: Domestication and commercialisation of multi-purpose indigenous trees and shrubs for food and other products in Papua New Guinea, the Solomon Islands and Queensland: a feasibility study with special reference to *Canarium* nut

Overseas Collaborating Countries	Papua New Guinea, Solomon Islands
Commissioned Organisation	James Cook University, School of Tropical Biology, Australia
Project Leader	Professor Roger Leakey Phone: 07 4042 1573 Fax: 07 4042 1319 Email: roger.leakey@jcu.edu.au
Collaborating Institutions	National Agricultural Research Institute, Papua New Guinea Queensland Department of Primary Industries and Fisheries, Australia Macro Agribusiness Consultants Pty Ltd, Australia Michael Davis Consultants, Australia Commodities Export Marketing Authority, Solomon Islands
Project Budget	\$203,606
Project Duration	01/07/2004 to 30/09/2005 (Project extended from 01/07/2005 to 30/09/2005)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

The indigenous tree nut *Canarium indicum*, known as Galip Nut in PNG and Ngali in the Solomons, is part of human dietary intake in both countries. As a result the species is domestically important for food security but less so as a potential cash crop. Some attempts have been made to develop, process and market the nut but these have not resulted in widespread cropping.

Domestication of indigenous fruit and nuts is relatively common in many tropical countries. Such species are important to alleviating food insecurity and addressing nutritional deficiencies in dietary intake. They also provide an income opportunity that can help stimulate improvements in livelihoods. Such approaches towards domesticating indigenous species could also work in PNG and the Solomon Islands.

In PNG there are 22 species of *Canarium*, seven of which can be found in New Britain Province. Little, however, is known about these species, with this project likely to increase knowledge. A feasibility study of agroforestry of Galip/Ngali is needed to determine if barriers to tree domestication exist in PNG and the Solomons and if these account for the lack of agroforestry utilising *Canarium* and other suitable tree species. This study focused on existing participatory approaches that have been successful elsewhere in the tropics. The ability of agroforestry of Galip/Ngali to enhance food security and to create income-generating opportunities was also examined. The objective was to determine the feasibility of developing a strategy and methodology for the parallel improvement of the food/nutritional security, and income generating opportunities of smallholder farmers through the domestication and commercialisation of indigenous fruit and nut species in PNG (East New Britain), SI and Australia. Specific objectives were to:

1. determine the attitudes and perceptions of communities towards indigenous fruits and nuts in the household food intake and in landuse in East New Britain Province PNG
2. identify the potential opportunities and constraints to domestication and commercialisation of indigenous fruit and nuts in PNG, SI and Queensland
3. identify the research and development issues for domestication and commercialisation of indigenous fruits and nuts, including IPR and cultural issues
4. enhance the abilities of project staff in methodologies of community survey and interpretation
5. inform stakeholders and participants of the outputs and conclusions of the project.

Project outcomes

Although there were differences in the results observed from the three locations surveyed, the findings were fairly similar—despite differences in the population pressures and market access between the locations.

Importance of Galip

The farmers in ENBP ranked Galip as the most important nut tree species for both food and income generation. Pau was ranked second, followed by Aila, Talis and Okari. Other minor nuts were important to some respondents particularly in the Pomio area. A similar trend was seen in the number of farmers growing the different nut species. There was no difference in farmer rankings of the nut species for their importance as a food source or for income generation. Without exception all those interviewed said that they liked eating Galip. The majority liked eating Galip raw but over half also liked it prepared with other foods and 40% said they liked it roasted.

Galip is a multipurpose tree, in addition to the kernels being an important source of food and cash income Galip was also important for timber (including canoe making), firewood and for traditional and medicinal uses. Just about all parts of the tree (including the trunk, bark, nut oil, resin, leaves, young shoots, kernels, fruit flesh, nut shells and roots) are used by some people.

Production

The average farming family generally had access to 5–12 Galip trees, with a few having large numbers (up to 150 trees). The farmers in the Duke of York Islands tended to have more trees than those in the Gazelle and Pomio. The majority of these trees were self planted—only about a third said they had planted them. If farmers had planted Galip the number planted per farmer was generally less than five. The planting was done by all gender groups with a slightly higher involvement of men. There was very little movement of Galip germplasm from outside individual villages. Only one person had planted material from outside their own district and 20% said they planted materials obtained from outside their own village. The rest of the farmers said they obtained the planting materials from trees within their village.

Up to five Galip types were identified by individuals, with the majority recognising two or three types. Although a large number of local Galip names were given, there were generally two or three major ones at each location surveyed. The main distinguishing features for the different Galip types were the colour of the fruit around the nut shell, the shell colour, the ease of cracking the shell and the nut shape and size.

Most farmers said they had Galip types they preferred over others—taste, kernel size and ease of cracking and kernel oiliness were the main reasons given for the preference. One third of the respondents said they had no problems with growing Galip. For others, lack of knowledge, land availability, irregularity of fruiting and lack of planting materials constituted the main problems.

Nearly all the farmers interviewed indicated a desire to grow more nut trees than they currently do with Galip and Pau the preferred species. The reasons given for wanting to grow more Galip was for income followed by food and then traditional ceremonies. The reasons for wanting to grow more Pau related more to the nature of the Pau, a smaller backyard tree that starts bearing at a young age and has a non seasonal production.

Seasonality

Although the data were not very clear it appears that the fruiting period may vary in different locations of ENBP. This would be an advantage for improving continuity of supply if correct. Further work is required—to accurately determine the fruiting patterns of Galip in the different locations and establish the factors affecting the timing of the main production periods.

Postharvest

The Galip is generally harvested equally by all gender groups. The main method of harvesting is to collect fallen nuts from the ground, however climbing the trees to harvest and cutting the fruit-bearing branches down are also important methods, particularly in Pomio. The maturity of the fruit is determined by the skin colour change from green to dark purple or black (or dark maroon in some cultivars) or when they start to fall from the tree. The main problems farmers had with harvesting the Galip nuts was trees that were too big and dangerous to climb to harvest the fruit, stealing, and the fruit being eaten by animals (flying foxes and pigs).

The methods of removing the fruit flesh from the shell were to let it rot off under the tree before collecting the nuts, letting it rot off collected nuts then wash them in water, gently hitting the flesh off with a stone or cutting the fresh fruit and removing the kernel. All respondents said they remove the kernel from the shell manually. Most of them use stones to break the shell while some used bush knives. The main problems encountered when removing the kernel from the shell was injuries to the operators hands. It was also very time consuming and some nuts were hard to crack and some kernels get damaged. Although the survey found all gender groups involved in extracting the kernels, it was more likely for women to do so as they are the ones who market the kernels.

Over half of the respondents had Galip cultivars that were easier to crack ('soft-shell' types) and most said they preferred soft-shelled cultivars. The majority of farmers store Galip nuts for a year or more; kernels are stored dried nut in shell, drying is done in baskets over a fire place or spread out in the sun. Few farmers reported problems associated with storing nuts but some had fungal or insect problems. Food security, out-of-season use and cultural ceremonies were the main reason given for storing the nuts.

Nut quality

Qualities that the respondents thought were important in determining good Galip nuts were big kernels, good taste, easy to crack shells and oily kernels. There was either a preference for nuts with only one kernel or the respondents were not concerned with how many kernels there were in the nut.

Marketing

Galip is very important as a source of cash, with 86% of the farmers selling some Galip. Women were the main gender group involved with the marketing of Galip, they were also assisted by the girls. Galip was sold as kernel for the fresh nut market, or as nut in shell if it was to be stored, or occasionally as whole fruit. More was sold as nut in shell or whole fruit in the Duke of York and Pomio than the Gazelle. There was very little grading or quality selection of the nuts prior to selling them in the markets, only a few graded by kernel size, shape or colour. All nuts were sold to the general public; there was no wholesaling or involvement of middlemen. The nuts were sold in central and road side markets if available (only in the Gazelle) or village markets. The pricing of the Galip depended to some degree on the supply and demand and on what others were selling at the time. In general it was higher in the Gazelle (K2.00 for 10–50 kernels) and lower in Pomio (20–50 toea for up to 100 kernels).

Due to the difficulty in obtaining economic information from the farmers and the reliability of the information gathered it is difficult to estimate how much farmers make from Galip. Results indicate that farming families make a about K40.00 per year from selling Galip and in some cases can be much higher—estimated to be K375.00 in one case. The money obtained from selling Galip generally was used for normal household expenses. Most farmers said they currently sell all the Galip they market and that they could sell more Galip if they had it, despite this the lack of buyers and the market competition were mentioned as problems by some respondents.

Tree improvement

The main improvements farmers said they would like to see in Galip is a reduction in tree size followed by increased yield, increased nut size, reduced seasonality, improved regularity of fruiting, better tree shape and improved ease of cracking the shell. Virtually all the farmers interviewed said they would like to plant Galip clones if they were available. The farmers in general said they wanted to plant large numbers of trees with 39% of them wanting to plant 50 or more trees. The main reasons given for wanting to plant more Galip trees was for additional income and family consumption.

FST/2005/049: Mastotermes scoping study in PNG

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Department of Primary Industries, Fisheries and Mines, Australia
Project Leader	Dr Brian Thistleton
Collaborating Institutions	
Project Budget	\$70,000
Project Duration	01/08/2005 to 31/05/2006 (Project extended from 01/02/2006 to 31/05/2006)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

The giant termite *Mastotermes darwiniensis* was inadvertently introduced to Lae during or shortly after World War II. Originally confined to the hospital and surrounding areas, in recent years the pest has recently rapidly extended its range to adjoining residential areas, government buildings and other infrastructure. The termite has the potential to develop into a major pest of the built-in environment, infrastructure, native flora, horticulture and agriculture right across at least the lowlands of Papua New Guinea. The aim of this contract then is to define the extent of the existing and potential problem, and to recommend responses. The specific objectives are to:

- Define much more precisely the current extent and nature of the incursion,
- Develop a prognosis of likely rate of spread and of the potential impacts, if no management strategies are adopted, and
- Propose practical longer term management options.

Project progress

The giant termite (*Mastotermes darwiniensis*) was first discovered in Lae in 1959 and from 1961 to 1973 was the subject of eradication attempts. The last small infested area at the nursing quarters at Lae hospital was treated in 1973 with the removal of all food sources including staff houses, treatment of colonies with arsenic dust and ripping the soil and incorporating heptachlor granules.

The current infestation appears to have started in the early 1990s in the nursing quarters close to the 1973 eradication attempt. It has since spread to adjoining areas including the main hospital area at the base of the escarpment and the adjoining Lae Botanical Gardens and the Forest Research Institute Building, where it was discovered in late 2001.

Since 2000 it has been present in the Okari Campus about 2 km north of FRI, and was discovered in the adjoining Police Barracks in 2004.

Dispersal flights appear to be uncommon despite winged reproductives (alates) forming in the colonies. Dispersal is through budding off at the edges of colonies through the workers (pseudergates) forming secondary reproductives (neotenic). This appears to be limited by the high water table and the existence of large drains which often have standing water or waterlogged soil.

Dispersal also occurs through movement of infested firewood and constructional timber and this is probably how it jumped from the hospital/FRI area to the Okari Campus/Police Barracks area. The ability of workers to moult to become secondary reproductives facilitates this process.

The current infested area is estimated to approximately 0.6 km² at the hospital/FRI area and 0.8 km² at the Okari Campus/Police Barracks area, a total of 1.4 km². This is far larger than the area at which the previous (1960–70s) eradication attempts were carried out. An eradication attempt on the current infestation is therefore likely to be a long-term and expensive operation, but this is offset by the very large amount of potential damage to crops and infrastructure if the termite establishes in drier areas of PNG.

In addition fipronil, the current control measure in use in tree crops in northern Australia (and a chemical not available in the earlier campaign), is a very effective termiticide which is carried by the termites through the colonies to a distance of 50 m. This would have the effect of controlling undetected infestations close to existing ones, which would have been missed with the chemicals in use during the 1960–70 campaign.

The National Agricultural Quarantine Authority (NAQIA) is keen to attempt to eradicate the insect and intends to declare it a notifiable pest. This proposal is supported by FRI, Provincial DPI, Department of Health and NARI. FRI has agreed to host an eradication attempt overseen by a steering committee from the above agencies and with possible involvement from NT DPIFM. All the agencies supported an official approach to a funding agency, probably AusAID, to set up an eradication team which would operate for a number of years.

FST/2005/050: PNG agroforestry systems—scoping study

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	Australian National University, School of Resources, Environment and Society, Australia
Project Leader	Professor Peter Kanowski Phone: 02 6125 2667 Fax: 02 6125 0746 Email: peter.kanowski@anu.edu.au
Collaborating Institutions	
Project Budget	\$149,442
Project Duration	01/05/2005 to 28/02/2006
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Native forests in PNG have generally been overexploited and will soon be commercially exhausted. Prospects for industrial-scale plantations are severely limited by land ownership issues. Such systems may offer the best prospects for landowners to benefit from tree growing and for sustainable forest industries based on local value-adding. This project aimed to build on Papua New Guineans wealth of documented local knowledge on agroforestry and innovative and adaptive farming systems. It also investigated opportunities for further enhancing PNG agroforestry systems through greater incorporation of high-value tree growing. It achieved this through a detailed review of relevant PNG farming systems, policy and literature; consultation with relevant stakeholders and officials; and synthesis of current knowledge and stakeholder judgement.

Project outcomes

The depletion of PNG's natural forests, the skills and innovativeness of many PNG landowners in adaptive farming systems, and the good market prospects for tree species that can be grown in PNG, create new opportunities for PNG customary landowners to benefit from deliberately planting and managing commercially valuable trees. This has been recognised in the development of a PNG National Ecoforestry Policy and in ACIAR's 2004 PNG consultation, which identified the 'improvement of traditional agroforestry systems' as a priority.

Research and experience in PNG farming systems and forestry suggest that there are both land-use systems and regions in which various forms of high-value tree growing could be developed on a commercial scale. Production systems and tree species are likely to vary between regions: for example, polycultural systems will be appropriate in some contexts, and small-scale monocultural systems in others. In some, tree planting may be financed primarily by farmers themselves or their customary land groups, whereas business partners may be required to co-invest in other cases. There is already good knowledge of PNG land-use systems, candidate species, and institutional and structural constraints to adoption, and some knowledge of landowner decision-making processes. There is also substantial international experience of the development of strategies which have been successful in fostering greater adoption of commercial tree growing by farmers.

Development and implementation of a strategy for facilitating commercial tree growing by PNG landowners need to take account of the current knowledge base and factors which determine adoption by landowners. Implementers also need to recognise the respective roles and capacities of the interested parties—governments, prospective investment partners, CBOs and NGOs, research providers, and landowners—in fostering commercial tree-growing. Although public policy is supportive of tree-growing by landowners, constraints to governments' capacity mean that incentive and support mechanisms will need to be developed by other parties, principally business and CBOs/ NGOs.

PNG landowners have a demonstrated enthusiasm for adopting new crops that generate cash returns and for which risks are low. Experience in other tree crop industries in which landowners participate—notably coffee, cocoa and oil palm—are instructive for the development of high-value tree growing strategies. This study has identified key factors influencing, and constraints to, adoption of tree-growing by PNG landowners.

Work conducted for this study suggests that an effective strategy for facilitating commercial tree-growing by PNG landowners could best be developed by focusing initial efforts on a small number of pilot regions, in which prospects are promising due to the presence and interest of potential investment partners. The proposed strategy would identify specific production systems and constraints to their adoption for each region, and address them in conjunction with investment and adoption partners.

HORT/1998/061: Coconut tissue culture for clonal propagation and safe germplasm exchange

Overseas Collaborating Countries	Indonesia, Papua New Guinea, Philippines, Vietnam
Commissioned Organisation	University of Queensland, School of Land and Food, Australia
Project Leader	Dr Steve Adkins Phone: 07 33652072 Fax: 07 33651177 Email: s.adkins@uq.edu.au
Collaborating Institutions	Philippine Coconut Authority, Philippines Cocoa and Coconut Research Institute, Papua New Guinea Research Institute for Coconut Palms, Indonesia University of the Philippines at Los Banos, Philippines Oil Plants Institute of Vietnam, Vietnam
Project Budget	\$805,329
Project Duration	01/07/2002 to 31/12/2005 (Project extended from 01/07/2005 to 31/12/2005)
ACIAR Research Program Manager	Mr Les Baxter

Project background and objectives

Coconut is the most important palm of the humid tropics and 96% of the crop is grown by resource-poor smallholders. Its traditional products are copra, coconut oil and copra meat, but it also has the ability to produce a wide variety of food and environmentally friendly non-food products which are used domestically and for export. The coconut palm has also been a stabilising factor in the farming systems of marginal and environmentally fragile environments.

The worldwide production of coconut has not increased in decades, due to the lack of new genetic stocks, devastation of crops from pests and diseases and rapid loss of precious coconut germplasm. Few of the coconut-producing countries have the capacity to characterise and evaluate the field performance of conserved germplasm. Many of these countries also lack the capacity to exchange disease-free germplasm with other coconut-producing countries because they are unable to undertake embryo culture, they do not have a capability to index diseases and their germplasm export clearances are tedious.

This project aimed to find an improved technique for coconut embryo culture which is suitable to re-establish palms from internationally exchanged and cryopreserved embryos. It continued existing research on the embryogenesis from somatic tissues and developed a protocol for the rapid production of true-to-type clonal palms. It also developed a technique to genetically analyse plants that have been developed from clonal propagation, embryo culture or cryopreservation. All the coconut biotechnological techniques gained from this project are being transferred to the collaborating countries.

Project outcomes

The first objective 'to establish an improved embryo culture technique suitable for the re-establishment of palms both from internationally exchanged or cryopreserved embryos' has identified the following improvements in the internationally recognised protocol for embryo culture. The physiological quality of the embryo used for tissue culture work has been identified as an important factor that, in part, determines the rate of seedling production from field-harvested embryos. Big embryos, from 11-month-old fruit of healthy trees produce more and healthier seedlings than those from poor quality embryos. Gibberellic acid (GA-3 at 30 to 40 μ M) placed into the tissue culture medium is able to promote the speed and percentage of embryos germinating. By reducing the medium carbohydrate load (from 45 to 25 g L⁻¹) at the last seedling subculture step, seedling growth can be improved and the rate of seedling establishment increased.

Auxins (IBA and NAA) (plant hormones) when applied at various times during the early steps of embryo germination will increase root production and this will result in greater *ex vitro* seedling vigour. A simple acclimatisation method, using a wooden box with a transparent plastic sheet lid, will produce better quality seedlings than those produced using the traditional inverted plastic bag system. Finally, CO₂ enrichment applied around young seedlings growing in a nutrient solution will promote seedling growth and development. The use of CO₂ is able to cut the time *in vitro* from 12 to approx. 3–4 months. This represents a massive saving in culture cost and time. Other work has demonstrated that embryo transplantation is another way of producing seedlings from embryos, and to do this a surrogate nut is used as a nurturing host.

Using the new, improved method for embryo culture, it is now possible to start looking at the possibility of conserving coconut germplasm (in this case embryos) by cryopreservation. To date we have shown that coconut embryos can be kept alive, through a period of cryopreservation (-196°C) if they are appropriately desiccated or dehydrated before being frozen. A dehydration approach adapted for use with coconut embryos gave better survival results after cryopreservation.

The second objective 'to continue work on somatic embryogenesis from somatic tissues with a view to developing a protocol for the rapid production of true-to-type, clonal palms' has identified improvements in the protocol for somatic embryogenesis of coconut. Techniques developed for hardening embryo-derived seedlings are also most useful for establishing somatic seedlings in soil.

The third objective 'to develop a technique for the genetic analysis of plants coming from clonal propagation, embryo culture or cryopreservation' has shown that the clones analysed in this project are genetically similar (stable) at the DNA nucleotide and methylation level following their production by somatic embryogenesis.

The fourth objective 'to transfer all coconut biotechnological techniques, and when they become available, to the COGENT-supported germplasm banks in Indonesia and PNG by way of short courses and training workshops' has presented training activities covering the use of all protocols used in all of the research programs of the project, with an emphasis placed on those used in the embryo culture program. Many other training activities have been undertaken at the partner institutes.

Community impacts

The major impacts of this project are within the subsistence-based coconut farming communities of south-east Asia. The improved protocols for establishing and acclimatising tissue-cultured coconut plantlets will make the use of elite types (including Makapuno and aromatic types) possible as well as creating a possibility of using clonal-propagated coconuts in the future. This in turn will make available to farmers planting materials that are high-yielding, of high value and/or disease-resistant.

Scientific impacts

The scientific impacts of this project are within the areas of creating methods for germplasm conservation and clonal propagation for coconut. The successful transplantation and germination of zygotic embryos from donor to surrogate coconut fruits opens the way for the development of a new protocol for raising coconut seedlings following the International exchange of germplasm. The improved protocol for establishing and acclimatising tissue-cultured coconut plantlets represents major steps forward in achieving high-efficiency embryo culture. The development of a cryopreservation approach will allow germplasm to be stored under protective conditions with greater security from diseases, insects, drought and storms. The development of a protocol to test the genetic fidelity of plants coming from tissue culture and its application to show that this may not be a problem in coconut are important steps in establishing a clonal propagation method for coconut.

Capacity impacts

The project has greatly improved the capacity-building potential of all the partners involved. Considerable experience has been gained by all partners in undertaking the research programs and through interaction with their peers.

LPS/2001/077: Poultry feeding systems in PNG

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	South Australian Research and Development Institute, Pig and Poultry Production Institute, Australia
Project Leader	Dr Phil Glatz Phone: 08 8303 7786 Fax: 08 8303 7689 Email: glatz.phil@saugov.sa.gov.au
Collaborating Institutions	National Agricultural Research Institute, Papua New Guinea Morobe Provincial Division of Agriculture and Livestock, Papua New Guinea Madang Provincial Department of Primary Industries, Papua New Guinea Salvation Army Development Program, Papua New Guinea Lae Feed Mills, Papua New Guinea
Project Budget	\$449,975
Project Duration	01/07/2002 to 31/12/2005 (Project extended from 01/07/2005 to 31/12/2005)
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

The Papua New Guinea (PNG) smallholder broiler production system involves about 50,000 families and produces six million birds a year, with a value of \$A54 million. Smallholders purchase day-old chicks, grow them out for six to eight weeks using commercial feeds and some locally available feeds, and sell them as live birds in local markets. At present, most farmers use imported concentrated feeds that cost \$A4–5 per bird.

Cheaper inputs would help smallholders to be more profitable and efficient. In particular, the use of locally available feeds could reduce costs by up to A\$1.50 per bird. However, locally available feeds must first be systematically evaluated and rations formulated using those feeds. This requires a more extensive testing facility than is currently available in PNG and better information about productivity using different local feeds. The profitability of smallholder broiler chicken production in PNG will be improved by identifying cheaper local food sources and reducing reliance on imported feed.

The aim of this project was to improve the profitability of smallholder broiler chicken production in Papua New Guinea (PNG) by identifying cheaper local food sources and reducing reliance on imported feed.

Project outcomes

Objective 1: To establish a quality-assured research facility in PNG to determine the quality of poultry feeds.

Cages and other equipment for the apparent metabolisable energy (AME) unit at NARI were made in Adelaide and shipped to Lae in 2003. The project successfully established a quality assured AME facility for poultry at the NARI Labu facility near Lae, defined the quality of several PNG feeds by undertaking AME trials, conducted a number of grow-out trials to test a range of composite ration bases, using local and commercial feeds, developed fact sheets on PNG feed resources and, importantly, developed the skills of NARI staff.

Objective 2: To formulate and evaluate low-cost milled and home mix rations based on locally available feeds.

A variety of feed resources from PNG were tested using the AME feed evaluation unit. These included maize, wheat, sorghum, sweet potato, sago, cassava, banana and legume leaves, plus various industry by-products, including millrun, rice bran, palm kernel meal, copra meal, tuna offal meal and pyrethrum marc. Several of these had AME values and protein content high enough to be considered as concentrates (about 10% of the ration) such as copra meal (15.0 MJ/kg). Other traditional staples, such as cassava (15.9 MJ/kg), sago (15.0 MJ/kg) and sweet potato (15.4 MJ/kg), had sufficient energy and were freely available in PNG to be considered for use as major components in broiler diets.

Birds (3 weeks of age) fed diets for 7 days in the AME unit with low inclusion rates (10%) of cassava, sweet potato, palm kernel meal and copra meal performed well. Copra-meal-based diets were superior. Evaluation of local feed resources over the full growing period of broilers were also undertaken with diets containing maize, cassava, copra meal, fishmeal and leucaena leaf meal. These diets were compared with a commercial ration comprising mainly imported feeds. In some trials feed conversion was superior in the commercial ration. Palatability and excessive proportions of local ingredients (eg. copra meal) may have contributed to poorer feed conversion. In other trials there was no difference between the commercial or the PNG feed-based diet.

An alternative feeding strategy was developed. It involved the development of a high protein poultry concentrate containing fishmeal and copra meal. The concentrate was fed with 70% of sweet potato (a high energy source). Research and village trials were conducted to evaluate the concentrate feeding strategy. The promising results from the on-station evaluation of the concentrate were followed by a preliminary on-farm evaluation, conducted by the Salvation Army in the Eastern Highlands Province near Kainantu. The trial with 60 village broiler units compared the performance of birds fed a commercial diet vs a treatment diet comprising the poultry concentrate fed with cooked sweet potato. While the higher moisture content of the treatment diet (containing 70% sweet potato) resulted in a higher feed intake (4.26 vs 4.0 kg/bird) and a lower live sale weight (2.0 vs. 2.4 kg) the net income from sale of live birds was only about 5% lower for the concentrate + sweet potato diet. This was a promising output from just one concentrate/local feed option, and further evaluation of the profitability of a range of concentrate diets + local feeds is warranted.

Objective 3: To establish a system for the exchange of information with smallholder farmers about low-cost rations for poultry production.

In 2003 a survey of 250 PNG smallholder farmers was conducted in the Morobe, Madang and Eastern Highlands Provinces. Information was obtained on chicken feeding practices, farmers' attitudes, constraints and their needs in raising meat chickens. Broiler chicken farming in these regions provides an additional source of income for families and is not done on a large scale. Most farmers started farming broilers on their own initiative. The husband and wife share the workload; men do most of the travelling and purchasing, while women do most of the selling. Feed and travel costs are a burden. Demand for live birds is high. Farmers have similar problems; price of chickens and feed, no access to information and no help from the government system. Most farmers agreed that farming chickens was easy and little experience was required, but was time consuming. Respondents to the survey welcomed the opportunity to have Extension Officers visit their facility to provide advice on poultry, sources of low-cost feed, disease control, business management, planning and financial opportunities.

In Australia:

Objective 4: To establish a free-range broiler production facility and evaluate local feeds.

In the Australian component of the study conducted at Roseworthy Campus, a free-range broiler facility was established in 2003. Details have been posted on the SARDI website (<http://www.sardi.sa.gov.au>). Studies demonstrated that free range broilers can be grazed in association with typical pasture/crop rotations in Australia or provided up to 10% of forage in the diet without major impacts on live sale weight.

SMCN/2005/043: Analysis of biophysical and socio-economic constraints to soil fertility management in the PNG Highlands

Overseas Collaborating Countries	Papua New Guinea
Commissioned Organisation	University of Queensland, School of Land and Food Sciences, Australia
Project Leader	Dr Gunnar Kirchhof Phone: 07-33651364 Fax: 07-33651177 Email: g.kirchhof1@uq.edu.au
Collaborating Institutions	Australian National University, Australia Queensland Department of Primary Industries and Fisheries, Australia National Agricultural Research Institute, Papua New Guinea
Project Budget	\$149,662
Project Duration	01/08/2005 to 30/06/2006
ACIAR Research Program Manager	Dr Christian Roth

Project background and objectives

In Papua New Guinea's highlands soils are rich and productive. Both crop production and agroforestry are widely practiced. The most extensively grown crop is sweet potato, the main food staple, cultivated on between 50 and 90 per cent of arable land. Recent declines in sweet potato yield suggest soil fertility is also declining. Pests and diseases may play a role, as may the shortening of fallow periods to cater for increased cropping to feed a growing population. Understanding the factors contributing to soil fertility and sweet potato yield decline is needed to guide future R&D activities. Information to build this understanding was collected to determine these factors, including the socio-economics of farmer decision-making.

Project outcomes

The project team surveyed farmers and assessed their gardens to evaluate if soil fertility and associated production of the most important staple, sweet potato, was indeed declining as a consequence of increasing land pressure, shortening fallow periods and a number of other factors including pests and diseases. This survey included 95 farmers in four Highland provinces with an average of three villages in each province. Farmer's perceptions on soil fertility decline and management options were obtained. They were then asked to show the team one garden which had recently been brought back into production after fallow, the 'new' fertile garden, and another garden which was about to go into fallow, the 'old' run-down garden. Plant and soil samples were collected from these two gardens to quantify changes as a result of cropping over time.

Sweet potato yields

Sweet potatoes are harvested sequentially, making it notoriously difficult to obtain reliable yield data. The team used single harvest yields to assess relative production from this 'one-off' farmer survey. In both gardens, old and new, single harvest yields of up to 30 t/ha were observed with a median yield of 6 t/ha. Due to the sequential harvesting these yields were considerably lower than the average total yields of 13–15t/ha for lowland and highland systems reported by Bourke and Vlassak (2004). The large variation in the measured yields and cultivars prevented the use of covariates such as number of previous harvests and age of sweet potato plant to estimate total yields. However the team's observations were similar to others (2006) from an EU funded project on early maturing sweet potato varieties in the lowlands executed by NARI.

Likely causes for the low yields were nutrient deficiencies, pests and diseases and presence of viruses in the sweet potato planting material (traditional and improved). Nutrient deficiencies were evident even though the predominantly volcanic ash soils in the Highlands are regarded as very fertile soils. In a 1997 study more than 50% of sweet potato tissue samples collected were deficient in N, P, K, S and B. Unclean planting material is also a major contributing factor to low yield, but it is unclear if pathogen-tested varieties would suffer nutrient deficiencies comparable to traditional varieties.

Yield trends in old and new gardens

Even though yields were low, there were subtle differences between the new and the old garden. The median yield in the old garden was 4 t/ha and 8 t/ha in the new garden. Given the very large variation in yields it is more realistic to assess 'expected' yield difference between the gardens. Within a 95% probability the expected yield difference ranged from 2 to 8 t/ha. This large difference clearly showed substantial changes in production potential as gardens are continuously being used for sweet potato production. If the factors driving yield in new gardens are known and can be managed, substantial yield reductions as gardens age can be avoided, even within traditional sweet potato varieties.

Pests and diseases: The cause for low yields in old gardens?

There was no difference in the degree of insect infestation of tubers between the old and new gardens ($p=13\%$). There was also no significant difference in the expected percentage of cracked tubers between the old and new gardens ($p\text{-value} > 7\%$). But the average yield of vines with cracked tubers was higher in the new gardens, indicating that new gardens produce higher yields even though tubers may have cracks.

Despite higher yields, the new gardens tended to have larger counts of nematodes ($p=5\%$), suggesting that the nematodes could be either non-parasitic or infestation is not a critical factor driving yield. The distribution of weevils was significantly different between the old and new gardens. The chances of the presence of weevils or larvae are significantly higher in the old garden ($p\text{-value} < 1\%$). Weevil infestation was also associated and increased with the number of times old gardens were harvested. However, the differences between new and old gardens still persisted even after adjusting the yields for weevil infestation.

Location and soil properties

Separating altitudes into low (<2200m) and high (>2200m) showed that high altitudes have considerably higher total N and soil organic carbon (SOC) than the lower. Despite these subtle differences in apparent soil fertility they had no impact on sweet potato yield. This is of particular interest because SOC is often regarded as an important indicator for soil health and fertility.

Farmers perception

The farmer's response to the survey was a strong willingness to cooperate. Farmers related yield reduction to soil fertility decline and were eager to collaborate as partners and requested feedback from our work. Their observation was that yields in older gardens are lower than in newer gardens and they blamed poor soil conditions for this decline. We asked farmers whether they could grow corn or common bean as a control question to assess their ability to judge soil fertility. The responses to both questions were closely related and farmers thought that the new gardens were more suitable for growing corn or common bean than the old gardens (corn $p=4\%$, bean $p=8\%$). However, the farmer's soil fertility assessment was not related to the sweet potato yields we observed, but it supported the argument that soil fertility differences exist between old and new garden.

Soil fertility management and planting systems

Yields in the new gardens were not affected by planting systems, but yields in the old gardens were highest if farmers used large mounds. In both, old and new gardens, mounds more than 70 cm high were associated with fertility management such as composting and short fallow (in old gardens). The high mounds system was mostly associated with high altitude. However, the difference in planting systems does not explain all the effect of altitude ($p < 1\%$). Rainfall had an additional effect on the expected yield. The rainfall, planting system in old and new gardens and altitude effects together explain 25% of the observed variability in yield.

Conclusion

The results from this scoping study support the call for urgent in-depth field based research on soil fertility and nutrient cycling on the Andisols of PNG with particular reference to soil water. Current methodology to assess the production potential of these soils also requires revision.

FIS/1999/025: Optimal release strategies for restocking and stock enhancement of the tropical sea cucumber, sandfish (*Holothuria scabra*)

Overseas Collaborating Countries	Papua New Guinea, Solomon Islands
Commissioned Organisation	WorldFish Center, New Caledonia
Project Leader	Dr Warwick Nash Phone: 687 262000 Fax: 687 263818 Email: w.nash@cgiar.org
Collaborating Institutions	Australian Institute of Marine Science, Australia Ministry of Agriculture and Fisheries, Solomon Islands
Project Budget	\$1,171,638
Project Duration	01/04/2000 to 30/06/2006 (Project extended from 01/04/2004 to 30/06/2006)
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Sea cucumbers, processed into 'beche-de-mer', are a valuable source of income for many coastal communities in the Pacific Islands and the developing nations of South and Southeast Asia. The sea cucumbers are easy to harvest, process and store. Wholesale prices for first grade beche-de-mer of around US\$50 per kg have resulted in severe over-fishing in many tropical developing countries. It is now apparent that depleted stocks of sea cucumbers can take decades to recover. The release of juvenile sea cucumbers produced in hatcheries is seen as the most expeditious way to rebuild stocks. Eventually, the release of cultured juvenile sea cucumbers also has the potential to increase production beyond historical levels.

ACIAR has funded research at the WorldFish Center in Solomon Islands to progressively develop, assess and transfer the technology for propagating and releasing tropical sea cucumbers. During the first stage of the project it was established that sandfish (*Holothuria scabra*) is the species most suited to restocking. They can be reared *en masse* in hatcheries on micro-algal diets, and juveniles can be grown in simple, land-based nursery systems with minimal input of food.

This project is the second stage of the partnership, which aims to identify the strategies for optimising survival of released juveniles, by developing cost-effective methods to ensure that a large proportion of cultured, juvenile sandfish released into the wild survive to adulthood.

Project outcomes

The project follows from the previous ACIAR-funded research conducted by the WorldFish Center (then ICLARM) in Solomon Islands, which developed methods for culturing the valuable sea cucumber, 'sandfish' (*Holothuria scabra*). Following conflict in Solomon Islands the project relocated to New Caledonia, partnered by the Secretariat of the Pacific Community (SPC). Higher costs to operate the project were met through substantial funding from the three Provinces of New Caledonia, the French Government and the ATSE Crawford Fund. Additional support was gained from internships of students from two French universities, INTECHMER and CREUFOP.

After constructing a simple 'field' hatchery (10 x 15 m) at the Saint-Vincent Aquaculture Station, tens of thousands of juvenile sandfish were produced from 2003 to 2005. Following the pioneering work by WorldFish Center in Vietnam, experiments were conducted to improve methods for growing sandfish juveniles in mesh enclosures in earthen ponds rather than in tanks. The approach occurs in two steps: firstly in 'hapas' (670 m mesh), then in 'bag-nets' (1 mm Tentex mesh). From a length of at least 5 mm, sandfish can be transferred from the hatchery to hapas in ponds. No feeding is required in hapas but growth rates were higher when units of 'fake seagrass', made from shade cloth, were included—a method that will speed up the time taken to grow juveniles to larger sizes for release in the wild. At 0.5 g in weight juveniles are transferred, at lower density, to bag-nets. Feeding and added sediments were not necessary in ponds with high natural productivity; otherwise, feeding with ground shrimp pellets was best. Reasonable survival in bag nets placed in the sea within sheltered bays suggested that opportunities exist for rearing sandfish at hatcheries without earthen ponds. But poor growth implied that research would be needed for managing bag nets at sea.

A study with IFREMER scientists showed that sandfish and blue shrimp (*Litopenaeus stylirostrus*) could be co-cultured as juveniles. However, further experiments quashed the promise of commercial co-culture since larger shrimp at commercial densities killed sandfish juveniles. Sandfish can grow well in ponds directly on the sediment, but are difficult to collect for release into the wild. Land-based grow-out is possible—estimated growth of juveniles of 1 g to market size of 500–1000 g in 1.5 years—but economic feasibility will depend on the costs for ponds, labour and seawater pumpage.

WorldFish collaborated with scientists at the Australian Institute of Marine Science to determine the genetic structure of sandfish stocks through allozyme electrophoresis analyses. Restricted gene flow of sandfish meta-populations directed a responsible approach of translocating hatchery-produced juveniles close to the natal sites of the broodstock. A further study, incorporating mtDNA sequencing, resolved the species distinction of a putative subspecies, the 'golden sandfish' *Holothuria scabra* var. *versicolor*, and showed that it can hybridise naturally with sandfish.

Sandfish juveniles are hardy for transport at high densities for up to 24 hours. Hatchery-based simulations affirmed that this is best done at cool (26°C), stable, temperature in buffered seawater. Collaboration with a Belgian scientist led to a published protocol for examining sea cucumbers for disease and health prior to release.

In a significant breakthrough, two fluorochrome markers, tetracycline and calcein, were effective in 'tagging' sandfish juveniles for at least 1 year. Experiments then pinpointed the optimal immersion conditions to fluorescently mark dermal spicules of juveniles. The marking is cheap and only 2–5 mm of outer body wall of an animal is needed for mark verification with an epifluorescence microscope. Marked sandfish released into the wild can now be distinguished from wild counterparts.

Small-scale field experiments, of 1–5 weeks duration using 1-m² sea pens, examined optimal release conditions. Several key habitat characteristics were identified for maximising the survival of released juveniles: water depth of 0.5–2.5 m, moderately high seagrass cover, and moderate penetrability of sediments. Restocking programs can be flexible about the release time, since post-release survival differed little among groups released at sunrise, mid-day or sunset. Size does matter; juveniles smaller than 1 g were at risk of complete mortality. Acclimation of juveniles in mesh enclosures showed promise to overcome the initial shock of transport and release into the sea.

Two large-scale experiments were then conducted, in which marked juveniles were released into 500-m² sea pens. The results gave encouraging expectations of survival up to 25% after 12 months. Sandfish juveniles should be released into No-Take Zones (NTZs) to preserve them as nucleus breeding populations for restocking fisheries. An Individual-Based Movement model, incorporating field data on sandfish movement and growth, showed that NTZs would need to be 19–40 ha to protect the released animals over a 10 year period.

WorldFish conducted broad-scale underwater surveys of sea cucumbers as a commitment to the Provincial governments. Sandfish populations in the Northern and Southern Provinces appeared heavily exploited, with few sites having plentiful breeding populations. In the Loyalty Islands Province, stocks of commercially-important reef-dwelling species were spatially variable but high densities of black teatfish (*Holothuria whitmaei*) still exist. WorldFish provided management advice to the fishery departments and plans to assess reef-dwelling sea cucumbers in the Northern and Southern Provinces in a forthcoming project.

Projects under development

(at 30 June 2006)

Bilateral

AH/2006/157	Animal diseases in Papua New Guinea
ASEM/2006/023	Re-commercialisation of the PNG pyrethrum industry and improving harvested yields in Australia
ASEM/2006/035	Improving marketing efficiency and post harvest handling of sweet potatoes in PNG
ASEM/2006/127	Private sector/smallholder partnerships for improving incomes in oil palm and cocoa sectors in Papua New Guinea
ASEM/2006/128	Farming systems incorporating a fodder component in the Highlands of Papua New Guinea
ASEM/2006/129	Early warning for low rainfall periods and preparedness for crop management and storage
CP/2006/063	Integrated pest management for Finschhafen disorder of oil palm in Papua New Guinea
CP/2006/065	Integrated pest management of pest coconut beetles in Papua New Guinea
FIS/2002/110	A whole of supply chain approach to the management of the PNG sea cucumber fishery
FIS/2004/066	Feed development in the Pacific Islands
FIS/2005/095	Strategic planning, PNG
FIS/2006/133	Study to evaluate options and opportunities to improve management arrangements for sea cucumber fisheries in PNG
FST/2004/050	Value-adding to PNG agroforestry systems
FST/2004/061	Assessment, management and marketing of goods and services from cutover native forests in Papua New Guinea
FST/2006/048	Improved processing, storage and packaging of Canarium nuts
FST/2006/088	Promoting diverse fuelwood production systems in PNG
FST/2006/120	Increasing downstream value adding in PNG's forest and wood products industry
HORT/2006/055	Developing the ornamentals industry in the Pacific: an opportunity for income generation
HORT/2006/106	Screening and field trials of high-carotenoid sweet potatoes for improving the vitamin A status of residents of the Solomon Islands and Papua New Guinea
LPS/2005/094	Improving the profitability of village broiler production in PNG
PLIA/2005/149	Papua New Guinea Cocoa project, policy analysis link
PLIA/2006/004	Papua New Guinea Coffee policy analysis
SMCN/2004/067	Management of soil fertility in sweet potato based cropping systems of the PNG Highlands
SMCN/2006/031	Fertility status of cocoa soils in PNG

Multilateral

CP/2006/114	Managing cocoa pod borer in PNG through improved risk incursion management capabilities, IPM strategies and stakeholder participatory training
HORT/2005/077	Integrated crop management package for sustainable smallholder gardens in the Solomon Islands

Papua New Guinea consultations

September 2004

Priorities for collaborative agricultural research and development between Australia and PNG were discussed in Lae and Port Moresby on 6-8 September 2004 at consultations between ACIAR and representatives of relevant PNG Government Departments, Statutory authorities, Research organisations, NGOs and the private sector. Although the priorities have been developed with close reference to the PNG 2003-07 National Medium Term Development Strategy, they are not to be considered as officially sanctioned priorities of the Government of Papua New Guinea. They are priorities expressed by participants at a consultation at a particular point in time. ACIAR will use them as a framework when assessing proposals for collaborative projects, subject to further advice and information from PNG. Researchers intending to seek ACIAR support for collaborative research projects should, in the first instance, approach one of ACIAR's Research Program Managers.

ACIAR's program recognises the many challenges to agricultural development in PNG, including poorly developed infrastructure, weak market signals and services, poor product quality, population pressure and future impacts of HIV/AIDS on the farming sector. ACIAR will work with counterparts to develop institutional capacity, and assist in communication and extension of the results of research. Major changes to the rural environment over last decade include greater exposure to global markets, devaluation of the kina, pressure on land and renewable resources as a result of population increases and new pest and disease threats. These mean that as well as making a greater commitment to the implementation of the results of research, the need for on-going development of agricultural technologies remains strong.

At the consultation, consensus was achieved on several over-arching issues. These include the roles of the private sector, industry bodies and NGOs along with government in research and implementation of research results; the importance of research that assists the engagement of smallholders in the cash economy. In a discipline sense the ACIAR PNG portfolio will emphasise agricultural economics, farming systems, protection and postharvest technology of crops, fisheries and forestry, with a limited number of projects in animal production and soil management and crop nutrition. The strategy for 2004-08 will emphasise four programmatic thrusts:

- Applied research aimed to maintain and enhance smallholder incomes, with an emphasis on root, plantation and horticultural crops and fisheries. The social and economic context of the research is emphasised particularly with respect to involvement of women farmers.
- Sustainable management of land, forestry and fisheries resources
- Biosecurity
- Institutional capacity building, socio-economics and project assessment, through development of human and physical resources

Major **training priorities**, in addition to those offered within projects and through postgraduate degrees, include experimental design and statistical analysis, including management of data quality; research management; research priority setting, monitoring and evaluation, impact assessment; scientific proposal writing and project design; presentation for scientific, extension, farmer and government audiences; collection and analysis of market information and training in extension approaches, including farmer participatory action research.

Interventions to maintain and enhance smallholder incomes

Root and horticultural crops

- Conservation, characterisation and utilisation of plant genetic resources (sugar, banana, taro, sweet potato, yam)
- Improved productivity and nutrition from smallholder farming systems, especially those based on sweet potatoes and peanuts
- Management of potato late blight
- Assessment and integrated management of pests and diseases of sweet potato and other root crops
- Postharvest handling and storage of sweet potatoes
- Integrated crop management for highland vegetable production
- Alternative crops to highland coffee, including horticultural and floriculture crops
- Market chain analysis (including quality incentives) for key commodities

Tree crops

- Cocoa and coffee marketing, quality management and crop protection
- Management of key insect pests and diseases of perennial fruit and tree crops and oil palm, (including fruit flies, banana scab moth and sigatoka disease, leaf hoppers, sago palm grubs and fungal pathogens)

Village livestock and aquaculture

- Enhanced productivity of existing inland pond aquaculture systems, and investigation of new opportunities including the domestication of indigenous species.
- Development of cost-effective formulated freshwater aquaculture feeds suited to local production
- Assessment of market options and opportunities for aquaculture production
- Low-cost feeds and feeding systems for chickens and pigs

Forestry and agroforestry

- Domestication and improvement of multiple-use, fast-growing indigenous trees species for smallholders and plantation development
- Processing of wood and non-wood products for value adding and local industry development, including utilisation of coconut wood and lesser known species
- Improvement of traditional agro-forestry systems, including fallow rotations, coffee, cocoa, vanilla cover crop management
- Development of lesser-known non-timber forest products for communities (including fruits, nut, fodder, oils and resins)

Sustainable management of soil, forestry and fisheries resources

Soil

- Maintenance of soil fertility in response to intensification of land use for annual and plantation crops
- Improving accessibility and usability of soil and land classification systems in PNG for use at both the field level and in making policy and investment decisions
- Implementation of research into coping strategies to address climatic extremes (drought, frost, excess rainfall) in vulnerable provinces

Forestry resources

- Native forest management, including ecology of forest regeneration after logging growth and sustainable yield planning (with information and inventory systems) for forest harvesting
- Sustainable management for smallholder woodlots and industrial plantations, addressing soil and nutrient conservation, productivity decline, and forest pests and diseases
- Reforestation of degraded sites including grasslands and mine sites

Fishery resources

- Simple village level mariculture options for enhanced livelihoods and to provide tools to support sustainable management arrangements for inshore fisheries resources
- Cooperation in the assessment and management of shared fish stocks in Torres Strait and Gulf of Papua
- Review of domestication policies and strategies for the long-line tuna fishery
- Assessment of impacts of fish-attracting device associated tuna fisheries on resource sustainability, particularly the capture of juvenile bigeye and yellowfin tuna

Biosecurity

- Capacity building for diagnosis and integrated management of plant pests, diseases and weeds
- Risk analysis and contingency planning for high-risk plant pests and livestock diseases

Institutional capacity building, socio-economics and project assessment

- Analysis of international comparative market advantage of selected PNG agricultural commodities
- Research addressing social and economic constraints and opportunities in smallholder production systems
- Institutional strengthening strategies for agricultural education and analytical services
- Approaches to research and development project planning frameworks and impact assessment
- Researching alternative approaches to extension

Crop Sciences

- Socio-economics of smallholder tree crop production systems
- Alternative approaches to smallholder tree crop extension and farming systems
- Application of biotechnology to coffee, coconut, cocoa improvement
- Conservation and characterisation of plant genetic resources and development of appropriate regional strategies
- Varietal assessment and agronomy of staple crops (sweet potato, banana, taro)
- Establishment of nutritional analysis for traditional/indigenous PNG crops
- Pest and disease management
 - especially of sweet potato weevil, oribius weevil, pink wax scale, red-banded mango caterpillar, taro beetle, fruit flies, banana scab moth and exotic diseases
 - development of IPM packages for staple and tree crops and introduced vegetables
 - capacity-building in diagnostics and indexing of viruses in PNG
 - application of non-chemical control, including weed biological control

Fisheries

- Management of shared fish stocks in the Torres Strait and Western Province
- Policy development and enhanced productivity of inland fisheries, pond aquaculture, stock enhancement and stocking of lakes and reservoirs
- Management of inshore fisheries resources
 - community management of sedentary resources
 - training/standardisation of resource assessment management and policy tools and methods
 - spillovers from reef mariculture/stock enhancement studies
 - management of Live Reef Fisheries
- Evaluation of past experiences with village-scale and community fishing enterprises

Forestry

- Sustainable management of natural forests, including biology/socioeconomic analysis, approaches for increased wood recovery and utilisation of non-wood forest products
- Plantations
 - restoration/reforestation of degraded upland grasslands
 - domestication for provision of germplasm for both agroforestry and plantation programs
 - genetic improvement of high-value species
- Postharvest processing
 - reduced waste/improved recovery through processing
 - preservation methods for improved durability leading to wider utilisation
- Development of information systems for herbarium management and domestication

Land and Water Resources

- Land management information systems, including the use, development and management of GIS databases, access to information from land-use archives
- Survey-based development of national weed management policy and systems
- Sustainable land management benchmarking through practical technology transfer models from long-term sites
- Nutrient management in intensive vegetable production and to shorten fallows in field crops
- Agroforestry for fallow management, fertility maintenance, and development of economic multiple cropping systems
- Impacts of excessive/deficient soil water from drought or flooding in traditional or innovative cropping systems

Postharvest Technology

- Market and product quality analysis for domestically-consumed crops and potential export crops
- Reduction of post-harvest losses in domestically-marketed food crops
- Development of processing methods for vanilla, sweet potato and sago
- Enhanced product quality and management of coffee and cocoa processing wastes

ACIAR publications

This list is a selection of titles from ACIAR's range of scientific publications that are relevant to PNG's agricultural research and development sector. Hard copies are available by emailing comms@aciar.gov.au, or may be requested through ACIAR's PNG office. Publications may also be downloaded from ACIAR's website, www.aciar.gov.au.

Impact Assessment Series

- 7 Reducing fish losses due to Epizootic Ulcerative Syndrome
- 12 Economic benefits to Papua New Guinea and Australia from the biological control of banana skipper (*Erionota thrax*)
- 19 Measuring the poverty impact of ACIAR projects: a broad framework
- 20 Mama Lus Frut Scheme: an assessment of poverty reduction
- 21 Improving methods in diagnosis, epidemiology, and information management of foot-and-mouth disease in SE Asia
- 22 Saving a staple crop: impact of biological control of the banana skipper on poverty reduction in Papua New Guinea
- 34 Identifying the sex pheromone of the sugarcane borer moth
- 35 Review of the returns to ACIAR's bilateral R&D investments
- 37 Management of fruit flies in the Pacific
- 39 Benefits to Australia from ACIAR-funded research

Monographs

- 06 Chemistry of tropical root crops: significance for nutrition and agriculture in the Pacific
- 12 Biological control – Pacific prospects: Supplement 1
- 20 Biological control – Pacific prospects: Supplement 2
- 28 The economics of Papua New Guinea tuna fisheries
- 32 Working with mycorrhizas in forestry and agriculture
- 33 Illustrated guide to the identification of banana varieties in the South Pacific
- 40 Essential oils of tropical *Asteromyrtus*, *Callistemon* and *Melaleuca* species
- 44 The major invertebrate pests and weeds of agriculture and plantation forestry in southern and western Pacific
- 45 Report on ACIAR-funded research on viroids and viruses of coconut palm and other tropical monocotyledons 1985-1993
- 48 Nutrient disorders of sweet potato
- 52 Improving smallholder farming systems in *Imperata* areas of Southeast Asia
- 54 Survey toolbox for livestock diseases: practical techniques for developing countries
- 58 Understanding animal health in Southeast Asia
- 66 A review of Papua New Guinea's red meat industry
- 76 Plant genetic resources in the Pacific
- 80 Setting policy priorities for the development of tree crop industries in Papua New Guinea
- 81 Policy options for the tree crop industries in Papua New Guinea
- 83 How to unravel and solve soil fertility problems
- 85 Fruits of Oceania
- 94 Survey toolbox for aquatic animal diseases: a practical manual and software package
- 99 Developing agricultural solutions with smallholder farmers
- 101 The coconut odyssey: the bounteous possibilities of the tree of life
- 102 *Lantana*: current management, status and future prospects
- 108 Pig husbandry in New Guinea: a literature review and bibliography
- 109 Community based resource planning: studies from Zimbabwe and Northern Australia
- 111 High-yielding anthracnose-resistant *Stylosanthes* for agricultural systems
- 113 Worm control for small ruminants in tropical Asia
- 115 Nitrogen fixation in acacias
- 119 Guidelines for surveillance for plant pests in Asia and the Pacific
- 120 Better-practice approaches for culture-based fisheries development in Asia

121 Planters and their components: types, attributes, functional requirements, classification and description
Proceedings

- 13 Bacterial wilt disease in Asia and the South Pacific
- 53 Coconut improvement in the South Pacific
- 57 *Leucaena*—opportunities and limitations
- 66 Bluetongue disease in the Asia-Pacific Region
- 69 South Pacific indigenous nuts
- 91 Fire management
- 97 *Hypsipyla* shoot borers in Meliaceae
- 99 Food security for Papua New Guinea
- 112 Breeding for drought resistant peanuts
- 116 Water in agriculture
- 119 Agriproduct supply-chain management in developing countries
- 120 Spiny lobster ecology and exploitation in the South China Sea Region

Technical Reports

- 14 Transport of vegetables in Papua New Guinea
- 15 Marketing perspectives on a potential Pacific spice industry
- 18 Post-flask management of tissue-cultured bananas
- 21 Production of pathogen-tested sweet potato
- 50 Mapping land resource potential and agricultural pressure in Papua New Guinea
- 55 *Chromolaena* in the Asia-Pacific Region
- 58 Evaluation of international provenance trials of *Casuarina equisetifolia*
- 59 Using seasonal climate forecasting in agriculture: a participatory decision-making approach
- 62 Pest and disease incursions: risks, threats and management in Papua New Guinea

Working Papers

- 53 Priorities for pig research in Southeast Asia and the Pacific to 2010
- 56 Agricultural research and poverty alleviation: some international perspectives
- 59 Economics and marketing of the live fish trade in Asia-Pacific