

Country Profile

# **Pacific Island Countries**

November 2005

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.

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GPO Box 1571 Canberra ACT Australia 2601

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Additional copies of this publication are available from ACIAR'S Australian office:

Communications Program Manager

Tel: +612 6217 0500

Fax: +612 6217 0501

Email: [comms@aciar.gov.au](mailto:comms@aciar.gov.au)

Postal address:

GPO Box 1571

Canberra ACT 2601

Website: [www.aciar.gov.au](http://www.aciar.gov.au)

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# Preface

The ACIAR Country Profiles are designed to give a snapshot of the collaborative research being carried out between Australia and our various partner countries. This publication contains short summaries of bilateral and multilateral projects with Pacific island countries that were active at 30 June 2005. At that time there were 20 active bilateral projects and 5 active multilateral projects, the latter being led by an international agricultural research centre. There were another 8 bilateral and 2 multilateral projects under development, many of which are expected to start in 2005–06 financial year.

This publication also sets out the key outputs and outcomes from 1 bilateral project that was completed since 30 June 2005.

In addition to these project summaries, the publication includes an extract from ACIAR's 2004–05 Annual Report covering the Pacific island countries, our near-term program as outlined in the 2005-06 Annual Operational Plan, and a record of the most recent consultations held between ACIAR and Pacific island countries on the medium-term priorities for the joint program.

ACIAR will update this profile each year and distribute it to key stakeholders in the Pacific and Australia.

We hope you find the publication useful as a record of the progress and achievements of ACIAR's collaborative research and development program with Pacific island countries. For information on ACIAR's overall program, we invite you to visit our website at [www.aciar.gov.au](http://www.aciar.gov.au).



Peter Core  
Director

November 2005



# Pacific Islands Report 2004–05

(extract from ACIAR Annual Report 2004–05)

Active projects in 2004–05	25
AOP budgeted expenditure in 2004–05	\$2,090,000
Actual bilateral country expenditure in 2004–05	\$2,105,536
Bilateral country expenditure in 2003–04	\$1,721,121
Bilateral country expenditure in 2002–03	\$1,583,522

Key performance indicators	Performance 2004–05
<ul style="list-style-type: none"> <li>New projects address emerging priorities agreed at formal priorities consultation held in December 2003</li> </ul>	Seven new projects commenced in 2004–05 and two scoping studies were undertaken, each of which address agreed priorities.
<ul style="list-style-type: none"> <li>Growth in budget for Pacific Islands compared with 2000–2003 levels</li> </ul>	Increase in Pacific budget in 2004–05 (\$2.1 m) compared with 2003–04 (\$1.72 m).
<ul style="list-style-type: none"> <li>Mini-project concept in fisheries research trialled and expanded</li> </ul>	Mini projects concept proven with three mini-projects complete, two in progress and three at late pipeline stage.
<ul style="list-style-type: none"> <li>Initiation of three new project/contract activities in Solomon Islands</li> </ul>	Three projects designed and implemented in Solomon Islands: sustainability and profitability of village sea cucumber fisheries, feeding village poultry; and improvement of plant protection.
<ul style="list-style-type: none"> <li>Initial sea cucumber mass release trials completed and hatchery technology transferred to several countries</li> </ul>	Final mass release trials in progress with hatchery technology transferred to Australia and discussions progressing for PNG.
<ul style="list-style-type: none"> <li>Two short-course training activities held to address identified needs</li> </ul>	Training workshops in fish nutrition and on taro pest identification held in Fiji.

## Position

ACIAR's program with the Pacific Islands has, in line with broader Australian foreign policy, expanded significantly in recent years. Addressing some of the major agricultural factors constraining socio-economic development will help to build a stable and economically viable Pacific region. Subsistence agriculture predominates in Pacific Island countries. Resources are limited—exports of commodities such as sugar, fruits and vegetables, spices, forestry products, and fish and marine resources are major income sources. Licensing of foreign fishing fleets to allow access to exclusive economic zones also provides revenue.

ACIAR's strategy in the Pacific addresses the significant challenges of developing markets for these products and enhancing smallholder income. Research focal points include the implications of World Trade Organization (WTO) accession, quarantine and bio-security issues and product quality, along with scales of production and the remoteness of export markets. Projects emphasise technologies appropriate to smallholders, the institutional uptake and dissemination of such technologies and the

adoption of a mix of value-adding, cash-generating and marketing outcomes that also enhance sustainability. Many projects yield results that are applicable to, and disseminated across a number of countries.

## Achievements

Fishing and marine resources are vital to economies of many Pacific Island nations, while providing food and income to smallholders. ACIAR has a number of fisheries projects active in the Pacific. Several are **targeting the sustainable utilisation of species**, through aquaculture and restocking depleted fisheries. Two projects are examining methods of restoring depleted sea cucumber and trochus populations. Methods for growing tropical sea cucumber (initially focusing on sandfish) have been developed, using fine mesh nets for growing-out juveniles in earthen ponds. This has significantly improved survival rates and numbers. Tagging techniques and plastic mesh enclosures are allowing sea pens to be used to improve the management of stocking densities. **Trials releasing up to 9000 juveniles** into such pens, prior to release into ocean fisheries are helping to refine growth methods to restock wild depleted areas.

In Samoa and Vanuatu the key stakeholders in trochus fisheries have worked to consolidate research areas as Marine Protected Areas (MPAs) for trochus. This parallels the work of West Australian Aboriginal groups restocking trochus on reefs near Broome. **Three sites are now established for trochus research** in Vanuatu and three also in Samoa. In Vanuatu the MPAs have aided in stock recovery with juvenile trochus densities increasing by an average of 70 per cent over pre-brood stock release, 12 months after brood stock were released. In Samoa staff at the AusAID-funded aquaculture facility have been trained in technologies for spawning trochus, with juveniles released for the first time.

**Sustainable aquaculture of several species is under way** through mini-research and development projects undertaken as part of a broader ACIAR project also involving the Secretariat for the Pacific Community, the WorldFish Center and the Queensland Department of Primary Industries and Fisheries. These mini-projects are targeting specific constraints in aquaculture industries by introducing the results of past ACIAR–WorldFish Center research. Commercial and farm-made feeds for tilapia and freshwater prawns in PNG and Fiji and testing of the viral status of black tiger prawns in Fiji are two examples. In Solomon Islands community groups are learning how to harvest post-larval coral reef fish and invertebrates for culturing and for sustainable wild capture. Already some villages have adopted the new approaches and are supplying fish and lobster to local exporters. Further extension activities are being planned, using a project-developed basic manual.

Developing black pearl aquaculture in Kiribati continues, following on from last year's successful mini-harvest of cultured pearls. Longlines that hold between 4000 and 5000 oysters have been deployed at three other locations in Kiribati to test the approach. In Tonga spat (juvenile oyster) production has continued with **hatchery production techniques now the responsibility of local staff**. A manual on culturing pearls has been developed and is now being distributed to project partners, including Solomon Islands where earlier research now supports a fledgling industry.

Licence fees paid by foreign fishing vessels to Pacific Island countries for entering exclusive economic zones (EEZ) are an important income source. A project is seeking to **maximise available returns** without threatening the sustainability of fisheries. The access fees are paid for the right to fish migratory tuna stocks. A bioeconomic model has been developed and a series of stock numbers run to assess fishing fleet efforts. This is enabling more accurate assessment of achievable access fees. Information gathered on catch and location is helping to determine the level of catch within and outside the EEZs.

Crops provide the bulk of staple food in the Pacific Island countries. A project operating with support from the Secretariat of the Pacific Community (SPC) aims to develop the unique plant resources of the Pacific by **building technical capacity** and establishing common ground between nations. An associated activity has been the development and publication of a Directory of Plant Genetic Resources in the Pacific Island Countries and Territories, which also includes information on germplasm held outside the Pacific.

Taro is one such important food staple. Research to improve the capacity of **quarantine services to diagnose taro diseases** is complete and diagnostic tests are available for all known taro viruses. As

a result taro germplasm can be virus-indexed before it is transported. Virus surveys have been conducted in Vanuatu, Samoa, American Samoa, Fiji, PNG, Solomon Islands and New Caledonia. Samples from Micronesia and the Cook Islands have also been collected and indexed. The result is a clear picture on virus distribution. PNG and Solomon Islands were found to have the most diverse taro germplasm in the region. These two countries will be the focus for collecting material to incorporate into breeding programs, including the AusAID TaroGen project.

Field trials for a control agent against taro beetle continue. A potential control agent has been identified and a **protocol for culturing the agent established and tested** to ensure its regular production. Trials are now needed to determine the effectiveness of this agent in broader-scale field settings.

Yam is another important crop but high soil fertility and good nutrition is needed for substantial yields. The final series of field trials that examined the impacts of the addition of nitrogen and phosphorus to soils planted with yam are now concluding. **Positive responses in yields have been identified.** In one location zinc deficiency was ameliorated by application of chicken manure. And a new project commenced in Tonga to develop improved management of powdery mildew and viral diseases that have threatened the squash industry, a valuable source of export income.

Research in several Pacific Island Countries and also in PNG is studying how zoonotic diseases affect animals by reducing productivity. These **diseases can also be transferred to humans** and are an increasing problem in villages in PNG and the Pacific. The antibody detection test developed last year is now available to PNG authorities for field testing and use. Surveys of affected areas have revealed that in PNG *Leptospira* species can infect humans and significantly contributes to cattle infertility. This is despite vaccination, suggesting that an optimal vaccination strategy is needed to boost its effectiveness. In Fiji the researchers determined the role of village dogs as carriers of zoonotic diseases and they are now establishing strategies to manage outbreaks by vaccinating dogs to break the transmission cycle before humans are infected.

Utilising animal waste safely and effectively has the **potential to reduce water-borne infection** and increase soil nutrient levels. Community groups involved in the project are learning to improve their environment by developing skills in managing waste and determining negative impacts on local waterways. They have also learnt to collect data to feed into the bio-economic model developed by project researchers.

Assessing groundwater resources on Kiribati has led to greater understanding of freshwater use. The depth and dimensions of the freshwater lenses on Tarawa are being determined, particularly to gauge their sustainability during drought. **A drought warning system** based on recent and historic rainfall data and water use is possible. Strategies to reduce pumping of freshwater have been developed, along with the identification of sustainable levels of water pumping during normal weather cycles. These help ensure that the transition zones that separate fresh and salt water are protected. A system to model these water dynamics, AtollScape, has also been developed.

Smallholders need to tap into commodities markets in order to generate incomes. In several projects scientists are exploring avenues for **sustainably exploiting horticulture and forestry resources.** In Samoa (and in Aboriginal communities in far-north Queensland's Cape York Peninsula) researchers are assessing the marketing strengths and opportunities of remote communities. Interviews with key stakeholders are revealing the nature of commodities produced and the means of developing horticulture to meet market needs. This information will help the building of extension services in both countries. A second project is also operating in far north Queensland and in Vanuatu to develop improved management of sandalwood trees—producers of valuable sandalwood oil. Harvesting the oil provides a valuable income source, but the resource base is declining. New research is seeking to improve current plantations and develop better management techniques for local industries in both countries.

A project now concluding in PNG and Solomon Islands has studied the potential for domesticating indigenous trees and shrubs to harvest food and other products. The canarium nut is one such resource that can be sustainably exploited for both food and medicinal purposes. Management options for harvesting the nut have been developed and refined. One issue to emerge was the importance of **managing Intellectual Property** through patents to protect the rights of traditional

owners. These issues were addressed in a training course held in the Solomon Islands as part of the project.

A project to support the build-up of **forest health surveillance systems** in Fiji, Samoa, Tonga and Vanuatu is now concluding. The main focus has been training to introduce improved methods and techniques, reinforced through practical, on-the-ground survey applications. The project has raised awareness of the need to monitor forests and plantations for pest and disease evidence and outbreaks, leading to the establishment of forest health surveillance units in each country.

Two projects have examined key economic issues relating to agriculture and global trade implications in Fiji. The first has developed an econometric model of the sugar industry to determine **likely impacts of global trade reforms**. Most data have now been entered into the model, allowing the identification of improvements needed at the farm and mill level. Such information is necessary to keep the industry competitive as the global sugar market changes. The second project, also examining implications of trade reform, aims to provide policy makers with sustainable options for land-use development. A number of key policy makers from government and non-government sectors, together with land owners and tenants, participated in a workshop to begin disseminating project findings. Data gathered through both the workshop and surveys will be used to develop the economic model and draw a fuller picture of land-use changes and pressures from trade reform.

# Pacific Island Countries Plan 2005–06

(extract from ACIAR Annual Operational Plan 2005–06)

Population <sup>1</sup>	1.8 million <sup>2</sup>	Bilateral actual 2003–04	\$1.7m
Population 2025/2050 <sup>3</sup>	2.5 / 2.9 million <sup>4</sup>	Bilateral forecast 2004–05	\$2.3m
Active bilateral projects	22	Bilateral budget 2005–06	\$2.5m
Active multilateral projects	3	Multilateral budget 2005–06	\$0.3m

GNI per capita <sup>5</sup>			
Fiji	AUD 3,638	Samoa	AUD 2,466
Solomon Islands	AUD 925	Tonga	AUD 2,297
Vanuatu	AUD 1,819	Kiribati	AUD 1,357

## Medium-term strategy

ACIAR's strategy in the Pacific addresses the significant challenges of developing and improving marketability and competitiveness for agricultural, forestry and fisheries products, including quarantine- and biosecurity-related issues, product quality, scale of production, remoteness of export markets, and implications of World Trade Organisation (WTO) accession. We will maintain a mixture of research on quality improvement and marketing, cash-generating crops, fishing, aquaculture and forestry, with emphasis on supply chain issues and production sustainability. Projects will emphasise technologies that are suited to smallholders and/or community level application. Increased attention will be given to follow up on past research to encourage adoption, while opportunities for closer linkages with NGOs and industry will be explored. Training and institutional strengthening is central to all projects.

ACIAR only invests bilaterally in nations of particular importance to Australia — Fiji, Solomon Islands, Vanuatu, Samoa, Tonga, and Kiribati. Pressure on limited research capability in the region, especially in individual nations, is an ongoing constraint. ACIAR therefore works closely with regional organisations, especially the Secretariat of the Pacific Community (SPC), in identifying research opportunities and executing projects.

## Key performance indicators (2005–06)

<sup>1</sup> Source: United Nations Population Division, 2004, *World Population in 2300*.

<sup>2</sup> Composed of Fiji (0.8 million), Solomon Islands (0.4 million), Vanuatu (0.2 million), Samoa (0.2 million), Tonga (0.1 million) and Kiribati (0.08 million).

<sup>3</sup> Source: United Nations Population Division, 2003, *World Population Prospects: The 2002 Revision*.

<sup>4</sup> Composed of Fiji (1.0 / 1.0 million), Solomon Islands (0.8 / 1.1 million), Vanuatu (0.3 / 0.4 million), Samoa (0.2 / 0.2 million), Tonga (0.1 / 0.1 million) and Kiribati (0.1 / 0.1 million).

<sup>5</sup> Source: Commonwealth of Australia, *Australia's Overseas Aid Program 2005–06*, Statement by Minister Alexander Downer, May 2005.

- Integration of at least two ACIAR project activities with farmer participatory research-extension activities supported under the SPC-DSAP (Development of Sustainable Agriculture in the Pacific) program
- Research leading to short-term improvement of export crops emphasised in at least two projects
- Costs and benefits of alternative management approaches for migratory tuna stocks identified
- Chemical and biocontrol options for taro beetle successfully trialled
- Policy and technical environments for the growth of aquaculture significantly improved in at least two countries
- Major forest health threats to Pacific plantations documented
- 40% of new projects designed to have significant farmer or policy-maker impacts within 5 years of completion

## Position

ACIAR's program with the Pacific has recently grown significantly, in line with broader Australian foreign policy and official development assistance priorities. Major factors constraining socioeconomic development of Pacific Island countries are small size, physical isolation, limited natural resource base, inadequate communications infrastructure, internalisation and aid/remittance dependence of many economies, limited opportunities for commodity exports, lack of competitiveness and market advantage of many agricultural products in an increasingly globalised trade environment, demographic factors including high population growth rates in some countries, and difficulties with retention of well-trained personnel. One of the four key themes of the Australian Pacific Regional Aid Strategy (2004–09) is to promote stronger broad-based growth, including 'strengthening the enabling environment for public sector development ... improving economic competitiveness ... with a focus on providing income generation and employment opportunities and sustainable management of the environment'. ACIAR's Pacific program aims particularly to underpin this theme of the Strategy.

The region's small renewable resources subsectors are dominated by subsistence/smallholder agriculture. Commodity exports include sugar, fruit and vegetables, vanilla, pepper, kava, hardwood logs and timber, softwood timber, fish and other marine products; substantial income is also gained from foreign vessel access fees to fishing grounds within each country's exclusive economic zone.

Commodity-based research on crop and livestock breeding and production may be cost-ineffective, and relevant technology can mostly be adapted from research carried out elsewhere.

Pacific Island countries have limited capacity to participate effectively in ACIAR's normal mode of bilateral collaborative research partnerships. Their participation in regional or multi-country programs and projects that address common problems partly overcomes these constraints. Projects will be designed to address risks associated with institutional instability, high staff turnover and limited depth of national staff resources.

ACIAR encourages the involvement of international centres in the region and supports some bilateral and regional collaboration, for example the WorldFish Center on village-scale mariculture and reef ranching, and the International Plant Genetic Resources Institute on genetic resources conservation.

## Indicative priorities

ACIAR most recently held a formal program of consultation on priorities with representatives of ACIAR's six bilateral partner countries and key regional organisations in Suva in December 2003. The outcomes of this consultation are available at [www.aciar.gov.au](http://www.aciar.gov.au) under Partner country priorities/South Pacific region. Senior ACIAR staff also meet regularly with the SPC, the South Pacific Applied Geoscience Commission (SOPAC) and the University of the South Pacific (USP). ACIAR also attends whenever possible the regular meetings of Forum Fisheries Agency; Permanent Heads of Fisheries; Heads of Forestry; Permanent Heads of Agriculture and Livestock Production Services; and Regional Technical Meetings of Plant Protection.

In 2005–06, ACIAR will emphasise projects in agricultural economics (including marketing and policy), crop protection and genetic resource utilisation, fisheries and aquaculture, forestry and postharvest technology. Potential areas for future collaboration are:

### *Crop sciences (emphasis on crop protection, quarantine and postharvest)*

- Identification of quarantine and pest risk issues for specific crop germplasm requiring exchange between countries for conservation and introduction purposes
- Development of integrated crop management packages (specifically for pest, weed and disease control and other quarantine issues), e.g. for breadfruit, yam, and sweet potato
- Integration of existing knowledge into information packages for bananas and taro
- Facilitation of national adoption of earlier research on pest, weed and disease management
- In Tonga, research on environmentally appropriate pest and disease management to maintain the export squash industry

### *Fisheries and livestock*

- Stock status assessment and management planning for the sustained use of vulnerable inshore fisheries resources, with an emphasis on increased community-level management and co-management approaches
- Economic and marketing analyses of key aquaculture commodities (initial focus to be seaweed) to better inform producer decision-making and to identify opportunities for regional cooperation in marketing and processing
- Regional studies of import risks associated with the movement of live aquatic organisms and the definition of appropriate quarantine measures and strategies
- Investigation of new opportunities for inland aquaculture, including the domestication of promising indigenous species and integration of aquaculture into existing farming systems
- Utilisation of locally available materials (including waste products) to develop cost-effective feed formulations which improve nutrition in pigs, poultry and aquaculture species

### *Forestry*

- Domestication of multipurpose trees for forestry and agroforestry, including selection of suitable germplasm and silvicultural management
- Sustainable management (and protection from pests and diseases) of high-value plantations and native forests, including silviculture, harvesting and re-establishment practices
- Value-adding processing of forest products, including coconut wood and lesser-known species, mahogany branch and salvage wood, and use of mobile sawmills for processing
- Control of exotic, invasive plant species in plantation and agroforestry, especially vine and tree species
- Watershed protection functions and groundwater management in forestry systems

### *Agricultural economics*

- Land and water resource use planning for optimal development of agriculture, forestry and fisheries enterprises
- Improved agricultural statistics to develop indicators that measure smallholder/ subsistence contribution to national economies; quantification of the number of farmers producing, levels of household consumption and supply chain linkages
- Marketing research for root crops, taro and cassava to underpin development of a structured supply chain, with emphasis on quality standards, consistency of supply and packaging requirements
- Economic analysis of current and new farming practices, including of alternatives to slash-and-burn agriculture and organic farming
- Economic analysis of returns and certification issues of current and potential crops or commodities
- Resource valuations and economic analyses of subsistence and commercial fisheries
- Analysis of the economic trade-offs incurred in moving from access fee arrangements for Distant Water Fishing Nation vessels to domestic allocation of tuna harvests and onshore processing/transshipment requirements

Follow-up activities that enhance the transfer of technology from earlier ACIAR projects will be pursued, and opportunities for greater involvement of NGOs and industry in projects explored. Projects will also endeavour to have a substantial training component, and short-term and postgraduate training opportunities will receive special attention. While the bulk of ACIAR's investment will be in the form of standard collaborative research, development and extension projects, ACIAR will consider additional modalities, including a greater number of small initiatives. These may include support of consultant visits to address small but urgent problems, and follow up from earlier ACIAR-funded projects.

Training priorities, in addition to those offered within projects and through postgraduate degrees, include experimental design and analysis, research management and evaluation, writing for research and extension audiences, the research–extension interface (including farmer participatory processes) and information and communication technologies. In all Pacific partners, but especially in Vanuatu, Solomon Islands and Kiribati, there is a critical need for additional agricultural researchers with postgraduate training.

Although several of the challenges for agriculture, forestry and fisheries are common to most Pacific nations, and much of the ACIAR program in the Pacific is delivered through regional organisations, we recognise that different nations have different priorities and requirements. Pacific Island country participation in regional or multi-country programs and projects addressing common problems will be the main project modality, although ACIAR will continue to support a limited number of single country-specific projects on major issues. A statement on strategy and research opportunities for each of the six Pacific countries through which ACIAR operates bilaterally is provided below.

## **Fiji**

Fiji's poverty level is comparatively low, though rural–urban income inequality is an increasing problem. There is a good natural resource base for agriculture, forestry and fisheries.

After a period of ACIAR project emphasis on crop and livestock production, a crop protection focus began in the 1990s. There has also been strong ongoing cooperation in fisheries. Agricultural economics research cooperation has recently become much more important. Fiji also hosts the main campus of the University of the South Pacific (offering potential for collaboration in economics, development, geography and marine science and for involvement of students), and the bases of the SPC Land Resources Division, the Pacific Forum Secretariat, and several relevant NGOs.

Sugar production is decreasing, and the development of alternative land uses for agriculture within a sustainable land management framework is a national imperative. We will support selected economic and technical research aimed at developing alternative crops to sugar and in understanding the impact of policy changes on Fiji's food production sector.

Development of promising horticultural crops such as papaya, spice and nut crops and accompanying postharvest technologies and marketing options are being explored, as are new fruit varieties with longer production seasons.

Research opportunities in fisheries may include continued genetic selection of freshwater finfish and giant prawns; aquatic health including quarantine and import risk assessment, restocking as a tool to rehabilitate sea cucumber fisheries; and improved feed formulations for finfish and shrimp. More research may be needed on marketing of fisheries products, including seaweed.

Some options for forestry cooperation include timber utilisation, value-adding to mahogany and native species, plantation management and health, and increasing the potential of indigenous forestry species.

## **Solomon Islands**

Subsistence agriculture and fishing sustain over 80% of the livelihoods of people. The recent civil conflict caused stagnation or collapse in the production and export of many commodities. Fish, timber, copra, palm oil and cocoa were previously substantial exports, along with minerals such as gold. Most Solomon Islanders live in isolated rural communities dependent on subsistence agriculture and intermittent crop and small livestock sales.

ACIAR has a significant number of completed projects in the Solomon Islands, covering culture of a range of fish species, marine protected areas, stock assessment and fisheries management policy; farming systems economics; production and diseases of root crops; insect pests; biological control of pests; and forest tree nutrition. ACIAR's Solomon Islands program has a strong fisheries emphasis, including economic and technical research to support the development of sustainable livelihood

opportunities based on the culture of coral reef animals. ACIAR has a long-term commitment to cooperation with Solomon Islands, with this effort strongly focused on activities that will quickly contribute to enhanced smallholder income generation.

The loss of field station and laboratory infrastructure in the national agricultural research system (NARS) means that we will collaborate in on-farm research and recognise that NGOs play an important role in agricultural service delivery. To this end we will encourage partnerships between national and provincial technical services and key rural NGOs in our projects. On-farm adaptive work will be a more feasible option under the present conditions.

Income generation initiatives, particularly in rural areas, remain important in the broader scheme of economic and social recovery in the Solomon Islands, and much of this necessarily needs to be in agriculture, forestry and fisheries. Immediate assistance can include small, short-term technical interventions in areas where ACIAR projects have developed significant expertise elsewhere in the region. In addition, ACIAR will explore opportunities for specific linkages with AusAID's rural livelihoods and broad-based growth strategy as it is operationalised in the Solomon Islands.

## **Vanuatu**

Vanuatu's agriculture sector (along with tourism) remains the main focus of the country's development strategy. The main activities relate to coconut, cattle, cocoa, and timber production, with traditional food production for subsistence and local markets. Smallholders also cultivate peanuts, potatoes, vanilla and peppers. Although Vanuatu is an agricultural exporter, the majority of the population is in the subsistence or informal sector.

ACIAR's past program in Vanuatu has emphasised fisheries, crop sciences and forestry. The major partner for bilateral cooperation in Vanuatu is the Ministry of Agriculture, Quarantine, Forestry, and Fisheries (MAQFF), although some strong farmers' associations exist, and linkages with the French Agricultural Research Centre for International Development (CIRAD) and the private sector also provide opportunities.

With horticultural crops, market analysis of crop commodities for identification of niche markets that Vanuatu can fill is required. Crop protection and postharvest technology research to underpin development of horticultural export markets, and assistance with work on efficacy of fruit fly baits and on management of fruit piercing moth, may also be required. We will ensure that earlier ACIAR support for research on root crops in the region such as taro, yam and sweet potato is extended, through production of field guides and other extension material.

Targeted research to underpin village-level fisheries (including aquaculture) as well as commercial fisheries is also required. Livestock research may be more important in Vanuatu than elsewhere in the Pacific Islands. Forest covers almost 40% of the total land area of Vanuatu, and policy and technical interventions for sustainable management of plantations and development of new species of commercial value for both plantations and smallholders are important. In forestry, assistance is needed in relation to assessing commercial prospects for native species, including sandalwood and *Canarium*, and controlling the *Merremia* vine.

## **Samoa**

Samoa has recently had comparatively strong economic growth across a range of sectors, including agriculture. Samoa has reasonable research capacity in agriculture, forestry and fisheries. The Ministry of Agriculture, Forestry, Fisheries and Meteorology (MAFFM) has several research stations and experimental farms. Samoa is also the Agriculture base of the University of the South Pacific, the FAO Subregional Program and the South Pacific Regional Environmental Program (SPREP).

There has been a strong emphasis in the ACIAR program on insect pest management (fruit flies, fruit piercing moth, whitefly and aphids), virus indexing of taro as well as biological control of pests and weeds. Some projects on forest nutrition and health and fisheries have been carried out.

There is expertise in Samoa in germplasm selection of root crops and fruits and in use of tissue culture propagation. Research opportunities include those that underpin the development of exports of high-value horticultural products. This may require postharvest research to improve shelf life and transport to underpin fruit exports (breadfruit, papaya, rambutan) and simple processing/value addition of fruit tree and root crops. Research to assist improvements in niche marketing of commodities, potentially including organic produce, is of importance. This may include identification of alternative extension and information transfer technologies.

In forestry, research opportunities may exist in the areas of: policy incentives for establishment of woodlots; nursery management techniques; forest weeds, pests and diseases; and better utilisation of timbers. Increasing wood yields from sawmilling is a high priority as there is currently significant wastage. In fisheries, opportunities may include research on community-based approaches to the management of reef fisheries. Technical interventions to underpin the development of community-level village aquaculture industries may be needed.

## **Tonga**

Factors affecting agricultural development include geographical isolation, fluctuations in export markets for Tongan produce, a limited natural resources base and governance structures. Tonga has high natural disaster susceptibility and limited income generation opportunities for outer islanders.

ACIAR's past program in Tonga has included many disciplines. For crop-related research, future support is likely to be in the area of marketing and postharvest quality improvement. Farming systems is a current emphasis.

Development of markets is an ongoing challenge, although Tonga has developed a successful export trade in pumpkin squashes over recent years. Research on environmentally appropriate pest and disease management to maintain this industry remains a priority. Other areas of research emphasis in Tonga include productivity of root crops and vegetables, development of new crops such as coffee and spices, and development of capacity in postharvest technology. Crop protection including fruit fly management is still important, as is better soil and water management for agriculture and other uses. Development of agroforestry-based farming systems, including tree legumes and fruit trees, is a priority, and is the main focus in forestry, since plantation resources are modest.

Tuna is the main fishery export from Tonga, and together with snapper and aquarium fish is a major export income source. Research will continue into the development of aquaculture systems for commercially important reef species (hatchery production and growout of blacklip pearl oyster, hatchery production of Winged Oyster to support Mabe pearl culture, etc.). There may be opportunities in the future for research to build on a current AusAID fisheries support project, in areas such as small-scale fisheries, for example of sea cucumber and community-based fisheries management.

## **Kiribati**

Kiribati is one of the poorest Pacific countries, having few land-based natural resources, but has jurisdiction over one of the largest Exclusive Economic Zones in the world. The small land area leads to a high and increasing population density on some of its atolls and an accompanying risk of environmental damage from agriculture and other human activities.

The large marine area in the country makes fisheries important for export and subsistence and a logical priority for cooperation. Issues such as tuna resource rents are critical for Kiribati, as is the identification of new village-level mariculture opportunities. There are only limited opportunities in other agricultural sectors, although further exploration of these areas will be pursued.

ACIAR's program in Kiribati has had a strong fisheries emphasis, most notable being the long-standing, ongoing effort directed at the development of a sustainable profitable pearl culture industry. Availability and quality of water for agriculture and domestic purposes is a critical issue. Research to reduce the dependence on imported food crops and on the conservation and use of traditional food

crops will link to opportunistic involvement in applied research on crop pests and diseases, including taro beetle, breadfruit fungal rot and biocontrol of spiralling white fly of pawpaw. In livestock, improved local feeds for pigs and chickens are important for food security.

Limited opportunities for recruitment of skilled human resources in Kiribati constrain opportunities for collaboration. The establishment of a new Central Agricultural Research Institute has been proposed, and ACIAR could assist with planning and training support.

### **Program Advisers**

Mr Barney Smith and Dr Simon Hearn

### **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 Greg Johnson, Postharvest Technology

Country Manager (for Solomon Islands)

Ms Margaret Newman, ACIAR Country Manager, PNG and Solomon Islands.

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**Project ADP/1996/136: Fiji sugar industry: assessing international sugar market reforms and their impacts and defining appropriate responses**

<b>Overseas Collaborating Countries</b>	Fiji
<b>Commissioned Organisation</b>	Australian National University, National Centre for Development Studies, Australia
<b>Project Leader</b>	Dr Padma Lal Phone: +679 3220329 Fax: +679 3300192 Email: padmal@forumsec.org.fj
<b>Collaborating Institutions</b>	University of the South Pacific, Fiji Sugar Commission of Fiji, Fiji Fiji Land Information Council, Fiji CSIRO Sustainable Ecosystems, Australia Ministry of Planning, Fiji Ministry of Agriculture, Sugar and Land Resettlement, Fiji
<b>Project Budget</b>	\$806,783
<b>Project Duration</b>	01/01/2000 to 30/09/2005 (Project extended from 01/01/2005 to 30/09/2005)
<b>ACIAR Research Program Manager</b>	Dr Ray Trewin

**Project background and objectives**

The sugar industry in Fiji accounts for about 40 per cent of the value of agricultural production, and 22 per cent of the country's entire GDP. Sugar is also Fiji's largest export earner and a major employer, providing work for about one quarter of the country's active workforce. Fiji has negotiated preferential arrangements with importers of its sugar, guaranteeing quotas at agreed prices. In 1997, about 56 per cent of the country's total sugar production was sold in this way. It is expected that preferential access for Fijian sugar to US and European Union markets will be lost as these nations review their agricultural policies. This will expose Fiji to international competition in the world sugar market where prices have been about half of those that Fiji sugar was enjoying under the preferential agreements. This is likely to have serious effects on the local industry and on the entire country's economy.

Fiji therefore needs to identify options that could help farmers adjust to the likely long-term loss of preferential access. But doing so is not possible without the relevant information and data. Once gathered, these will also form a useful basis for necessary policy reform. It is clear that the sugarcane farming system must adjust to remain viable. The project should provide the government, the sugar industry and the farmers with a range of options to help them effect the necessary changes, by:

- assessing the economic viability of sugarcane-based farming systems under current and alternative sugar price scenarios,
- assessing the financial and economic implications of various land tenure options proposed in Fiji, and
- evaluating the economic merit and sharing of the industry profits of the current and the proposed industry restructure and identify appropriate institutions — including facilitated markets — that could encourage economic efficiency in the sugar industry.

**Project progress****Year 5 (01/01/2004-31/12/2004)**

The year started off with the completion of the farm survey in March 2004, with another three months spent on data entry, data clean up and preliminary data analysis. The survey was highly successful, covering a 10 per cent stratified sample of farmers from each sector and each mill area, further stratified by ethnicity.

The survey results have been analysed and a draft survey report has been completed. Survey results were presented to the stakeholders for comment. The survey results were used to prepare a paper on the Impact of the EU reform on the Fiji Sugar industry. A PowerPoint version of this paper was presented to the industry stakeholder (FSC, SCOF, SIT, SCGC, FSM). The results were also fed into the preparation of the Fiji Paper for discussion in Brussels.

Parliamentary Submissions were made to the:

- Parliamentary Sugar Select Committee on Sugar, September 2004 — *Protocol prices and the future of the Fiji sugar industry*
- Parliamentary Ad Hoc Committee on Land, March 2005 - *ALTA-NLTA what is in the name: hybrid land model for Fiji*

*Training:* Two courses in Sugar-GIS Basic Training conducted. The first training was for the FSC staff — research and extension staff and IT personnel and SCOF. The second training involved the SCGC staff, SIT staff and two FSC staff who could not attend the first training.

A linked GIS-Database for the sugar industry was completed and 'handed' over along with a preliminary version of the Sugar-GIS Mapping System to industry stakeholders in December 2004 for trial.

*Sugar-GISInfo – an integrated GIS database for the sugar industry:* An NSS tool for use as in minimising conflict was completed and presented to industry stakeholders, at the Fiji Land Information Council, Industry Stakeholders. The same presentation was later given, at their request:

- to the Prime Minister's office, including to key participants such as the Deputy Permanent Secretary, Policy Advisory services, Deputy Permanent Secretary Special Projects Unit and other senior officials, and
- senior staff at the Native Land Trust Board.

## **Project ADP/2002/105: Economic and market analysis of the live reef fish food trade in Asia-Pacific**

<b>Overseas Collaborating Countries</b>	Fiji, Indonesia
<b>Commissioned Organisation</b>	Australian National University, Australia
<b>Project Leader</b>	Dr Brian Johnston Phone: 02 6125 6555 Fax: 02 6125 0767 Email: njvj@iimetro.com.au
<b>Collaborating Institutions</b>	University of Western Australia, Australia James Cook University, Australia WorldFish Center, Malaysia Secretariat of the Pacific Community, New Caledonia Bogor Agricultural University, Indonesia Central Research Institute for Marine and Fisheries Product Processing and Social Economics, Indonesia
<b>Project Budget</b>	\$399,066
<b>Project Duration</b>	01/07/2004 to 31/12/2006
<b>ACIAR Research Program Manager</b>	Dr Ray Trewin

### **Project background and objectives**

The fish markets of Hong Kong and southern China place a price premium on live fish. This trade is now worth an estimated \$US350 million a year. Fish are in demand for a number of factors: type, colour, taste and rarity. With population and economic growth continuing in southern China and Hong Kong and demand for live fish spreading beyond these markets it is anticipated that demand will rise substantially.

For many coastal communities the potentially lucrative returns from tapping into these markets have not been matched by the realities. A number of developing countries: Indonesia, Papua New Guinea, Vietnam, Fiji and other Pacific Islands are involved in the trade. For smallholder suppliers prices received for fish are usually low, reflecting the risk carried by those moving live fish from these areas to Hong Kong and China.

These low prices often result in overfishing to ensure greater returns. This threatens the sustainability of wild fisheries particularly where destructive practices are used. Another factor contributing to overfishing is a lack of knowledge of what fish species are desired by consumers. Knowing consumer preferences would allow more targeted fishing helping to alleviate stresses on wild fisheries through the development of sustainable management plans. It would also provide a focal point for aquaculture and mariculture enterprises and research to enhance productivity in these. Policy options to support the trade, including improving existing market supply chains, would also be possible.

This project aims to enhance the sustainable economic development of the live reef food fish trade, through economic analysis of policy options for improved market performance.

### **Project progress**

#### **Year 1 (01/07/2004-30/06/2005)**

Substantial progress has been made on the project in the first twelve months. Key tasks completed include data collection and analysis of the live reef fish trade in the Asia-Pacific, preparation and execution of a Pacific workshop and completion of a number of research papers. The project has developed collaborative partnerships with a number of key players including the Agriculture, Fisheries and Conservation Department of the Hong Kong Government, which has assisted with data provision, the ACIAR researchers working on grouper aquaculture, the World Fish Centre based in Penang, Malaysia, the Indonesian Center for Marine and Fisheries Product Processing and Social Economics and the Marine Resource Economics Department of Bogor University. Six Pacific countries with an involvement in the trade (Fiji, PNG, Kiribati, Solomon Islands and the Federated States of Micronesia)

and the Indonesian representatives participated in the Workshop held in Noumea, New Caledonia in March 2005. The participants were highly supportive of the project and indicated a strong willingness to participate in future stages of the project, including provision of data on their fisheries.

Extension material completed to date includes:

*Overview of the live reef fish market in Hong Kong*

- Issues in the Live Reef Fish Food Trade into Hong Kong – seminar presented to the Asia Pacific School of Economics and Government
- Economic and Market Analysis of the Live Reef Fish Food Trade in Asia-Pacific – paper.
- Economic and Market Analysis of the Live Reef Food Fish Trade in the Asia-Pacific – presentation.

*Pacific Workshop on Live Reef Fish*

- Live Reef Fish Trade in the Asia-Pacific : Workshop Outcomes.
- Workshop on Live Reef Fish Trade in the Asia-Pacific

*An analysis of the demand for live reef fish in the Hong Kong market :*

- Finding Nemo: Estimating import demand for live reef food fish – paper

*Market chain analysis*

- Market chain analysis for the trade in live reef food fish – paper
- Economics and Marketing of Live Reef Fish for Food in the Asia-Pacific
- Development of a spreadsheet model of the market chain for live reef food fish trade – unpublished paper.

*Bioeconomic modelling approaches*

- Bio-economic model development issues applications to coastal fisheries – paper

A Masters student studying at the Asia-Pacific School of Economics and Government (APSEG), Australian National University, Canberra is developing a consumer survey to be implemented in Hong Kong in September 2005. The purpose of the survey is to ascertain consumer attitudes to the role of aquaculture product to substitute for wild-caught fish in the market, and the implications of this for future labelling of the source of live reef fish sold in the market.

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

<b>Overseas Collaborating Countries</b>	Fiji, Kiribati, Papua New Guinea, Tonga
<b>Commissioned Organisation</b>	Murdoch University, Division of Veterinary and Biomedical Sciences, Australia
<b>Project Leader</b>	Dr Simon Reid Phone: (08) 9360 7423 Fax: (08) 9310 4144 Email: sreid@central.murdoch.edu.au
<b>Collaborating Institutions</b>	National Agriculture and Quarantine Inspection Service, 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
<b>Project Budget</b>	\$554,679
<b>Project Duration</b>	01/01/2002 to 31/12/2006 (Project extended from 01/01/2005 to 31/12/2006)
<b>ACIAR Research Program Manager</b>	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. Zoonotic diseases are capable of being transmitted directly from animals to humans. 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 project is working to determine the extent of the problem posed by zoonotic diseases, and to develop control strategies to reduce their impact.

### **Project progress**

#### **Year 3 (01/01/2004–31/12/2004)**

*Development of the capacity for effective surveillance:* Training was provided to a technician from the NVL in the use of an antibody detection ELISA to detect infection with *Leptospira* spp and *Trichinella* spp during a workshop at Murdoch University.

*Determine the prevalence of Trichinella, Leptospira and A. cantonensis infection in livestock:* Results of surveys conducted in PNG show that there is a high prevalence of infection with *Leptospira* spp in cattle in PNG and it is a significant cause of infertility in affected herds. These results show that the prevalence of infection is higher in large commercial herds and that there is evidence that attempts to control infection using vaccination have failed. However, the reasons for this apparent failure may relate to management issues and not the failure of vaccination *per se*. Further work is required to determine the optimal vaccination strategy.

A comparison of data from testing humans and animals was made in two villages in Fiji. This revealed that in the village that experienced human cases of leptospirosis the pattern of serovars affecting the human population most closely resembles the profile found in domestic dogs, opening up the possibility of interventions by vaccination of village dogs or by modifying the contact between the species.

Results from testing a total of 108, 48 and 73 serum samples collected from pigs from Fiji, Tonga and Kiribati respectively showed that the prevalence of antibodies to *Trichinella* were low. Only three pigs and one mongoose from Fiji were shown to have high levels of antibodies, which suggest that infection, if present is sporadic and may be present in Mongoose. Further work is required to determine the presence or absence of *Trichinella* in Mongoose because they are abundant and relatively easy to trap.

A field visit to Kikori in April 2004 investigated the potential source of *Trichinella* isolated from farmed crocodiles in Lae. This revealed that crocodiles held in the villages are fed on wild pig meat and fish prior to transport to the crocodile farm in Lae. It is likely that pigs are the source of *Trichinella* because larvae were recovered from the meat of a wild pig sold at Kikori market.

*Investigate the pathogenesis of T. papuae in pigs and Angiostrongylus cantonensis:*

Experimental studies in PNG showed that the larvae of *T. papuae* remain infective in pig meat for up to 26 days at 5°C and for 9 days in meat maintained outdoors at ambient temperature (32°C). This is important because it shows that surveys to recover *Trichinella* from animals in remote locations are possible if tissue samples can be refrigerated.

There was no evidence of clinical or subclinical disease induced by experimental infection of two merino cross-bred ewes with at least 1,000 L3 larvae of *A. cantonensis*. This suggests that *A. cantonensis* is not a significant pathogen of sheep.

## **Project ASEM/2004/011: Evaluating domestic tuna fisheries projects**

<b>Overseas Collaborating Countries</b>	Papua New Guinea, Solomon Islands
<b>Commissioned Organisation</b>	University of Queensland, School of Economics, Australia
<b>Project Leader</b>	Professor Harry Campbell Phone: 07 3365 6570 Fax: 07 3365 7299 Email: h.campbell@economics.uq.edu.au
<b>Collaborating Institutions</b>	National Fisheries Authority, Papua New Guinea Forum Fisheries Agency, Solomon Islands
<b>Project Budget</b>	\$331,431
<b>Project Duration</b>	01/04/2005 to 31/03/2008
<b>ACIAR Research Program Manager</b>	Dr Ken Menz

### **Project background and objectives**

Access fees paid to 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 will 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 apply 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)**

The first progress report is due in 2006.

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

<b>Overseas Collaborating Countries</b>	Fiji, Papua New Guinea, Samoa
<b>Commissioned Organisation</b>	Queensland University of Technology, Centre of Molecular Biotechnology, Australia
<b>Project Leader</b>	Associate Professor Rob Harding Phone: 61 7 3864 1379 Fax: 61 7 3864 1534 Email: r.harding@qut.edu.au
<b>Collaborating Institutions</b>	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
<b>Project Budget</b>	\$1,576,307
<b>Project Duration</b>	01/07/1998 to 30/06/2006 (Project extended from 01/07/2001 to 30/06/2006)
<b>ACIAR Research Program Manager</b>	Dr T K Lim

### **Project background and objectives**

Taro is widely grown in Papua New Guinea 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.

### **Project progress**

**Year 5 (01/11/2003-31/10/2004)**

*Characterisation of taro viruses and development of diagnostics:* Following characterisation of genetic elements investigation of the sequence variability in the genome of isolates from PNG, Solomon Islands, New Caledonia and Vanuatu TaRV in order to develop a more specific PCR test was conducted. Based on this data, a specific PCR-based diagnostic assay for this virus has now been developed.

A diagnostic PCR test for Taro vein chlorosis virus (TaVVCV) has now been developed for this virus following genetic sequencing work on a Fijian TaVVCV isolate. To help in diagnosing the Colocasia bobone disease virus (CBDV) a PCR-based diagnostic has been developed based on characterising a genetic region of a PNG isolate. Preliminary characterisation and analysis studies on TaBV-like sequences have indicated that the TaBV-like sequences present in taro are integrated sequences.

The characterisation of TaRV and the two rhabdoviruses has enabled the subsequent development of sensitive diagnostic tests for these viruses. As such, diagnostics tests have now been developed for all known viruses infecting taro. The availability of a suite of taro virus diagnostics will now enable taro germplasm to be virus-indexed, thus facilitating safe international movement of taro germplasm.

*Virus Survey:* Surveys were conducted in Vanuatu, Samoa, American Samoa, Fiji, PNG, Solomon Islands and New Caledonia. Samples were also provided from Micronesia and the Cook Islands. These samples have been indexed for all known viruses using the newly developed molecular-based diagnostic tests. The virus surveys, conducted in countries wishing to share germplasm under the TaroGen project, provided updated information on virus distribution. This data, combined with the results from virus-indexing from the TaroGen germplasm collection, allowed countries to make informed decisions on the importation of taro germplasm.

*Virus indexing of TaroGen taro germplasm collection held at SPC, Fiji:* One hundred and fifty-nine taro lines have been indexed for each of the taro viruses according to an internationally-recommended schedule. Safe international transfer of indexed taro germplasm will now be possible, allowing countries access to a diverse pool of germplasm with disease resistance and other agronomic qualities.

*DNA fingerprinting of national taro collections:* Taro collections were DNA fingerprinted using radio-labelled SSR (Simple Sequence Repeat) markers. Entire collections from Fiji, Samoa, Tonga, Niue, Palau, Cook Islands were fingerprinted. A 20 per cent sample of the country collection was fingerprinted from Papua New Guinea, Solomon Islands, Vanuatu and New Caledonia, as these collections were too large to fingerprint all accessions.

From the overall collection of 2206 accessions, 527 were DNA fingerprinted with SSR markers to assess taro genetic diversity within and between countries, and to identify a DNA fingerprint of accessions. It was evident that most (if not all) of the genetic diversity within South Pacific taros could be sampled from PNG and the Solomons. Evidence from this study and that of the EU-TANSAO study suggest that there are two centres of diversity, one in PNG/Solomons and the other in Indonesia/Malaysia. These should be seen as major sources of future genetic diversity for genetic improvement programs.

*Rationalisation of taro germplasm to form a core collection:* Based on DNA fingerprints a core collection for each country was selected. The aim of the core collection is to reduce the size of the collection to about 10 per cent of the total accessions while attempting to maintain at least 85 per cent of the genetic diversity available, which can then be conserved more easily and utilized more effectively. The core collection is stored as *in vitro* tissue cultures, primarily at the Regional Germplasm Collection at SPC in Suva, Fiji. Duplicate collections are kept at USP Alafua Campus, Samoa, with plans to maintain a sample at the International Potato Centre (CIP) in Peru, and negotiations are underway to maintain a duplicate collection in PNG.

## **Project CP/2004/001: TaroPest: a computer based information and diagnostics package for taro pests of the South Pacific**

<b>Overseas Collaborating Countries</b>	Fiji, Papua New Guinea
<b>Commissioned Organisation</b>	Queensland University of Technology, School of Natural Resource Sciences, Australia
<b>Project Leader</b>	Dr Anthony Clarke Phone: 07 3864 5023 Fax: 07 3864 1535 Email: a.clarke@qut.edu.au
<b>Collaborating Institutions</b>	Secretariat of the Pacific Community, Fiji National Agriculture and Quarantine Inspection Authority, Papua New Guinea
<b>Project Budget</b>	\$368,534
<b>Project Duration</b>	01/07/2004 to 31/12/2006
<b>ACIAR Research Program Manager</b>	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 will:

- produce a diagnostic and information package for taro pests and diseases of the South Pacific,
- enhance regional capacity in the ability to build and use Lucid based information and diagnostic packages, and
- test and incorporate user feed-back and dissemination of *TaroPest* to end users.

### **Project progress**

#### **Year 1 (01/07/2004 to 30/06/2005)**

The first full project meeting was held in Suva in January 2005, with representatives from PNG, Australia and Fiji. The outcomes of the project, which included Lucid training, was the development of a target list, prioritisation of species within that list, an agreed modified data sheet to ensure uniformity of data collated, a matrix-scoring datasheet, and formalisation of project time-lines.

Since the first project meeting, and in line with the project document, work has concentrated on collating information for the target pests, development of the first beta-version of the key, development of species fact sheets, image gathering, and training. With respect to the specific project objectives, the following has been achieved.

*Objective 1:* This objective is the core of the project and all activities are focused on it. Major achievements have been: the development and prioritisation of the target list; collation of information for more than 20 species on that list; development of a web-site (non-public at the moment) to allow live building and viewing of the key and species pages by team members.

*Objective 2:* Through a general workshop in Suva, specialist training for two technical officers in Brisbane, and a progress visit to Suva, training in Lucid has been provided at a variety of levels. Specifically, advanced training in all facets of the development of web-based Lucid keys and information packages have been given to one officer each of SPC and NAQIA. Relevant soft-ware and hard-ware has been supplied, along with training, to allow in-country development of Lucid based packages. This is the primary application of Objective 2.

*Objective 3:* Although few dissemination activities were planned for the first 12 months of the project, informal communication of the project aims has already occurred through a number of regional mediums, including Pacific Pest Info and IPMnet News.

## **Project FIS/1997/031: Pearl oyster resource development in the Western Pacific**

<b>Overseas Collaborating Countries</b>	Fiji, Kiribati, Solomon Islands
<b>Commissioned Organisation</b>	James Cook University, Department of Zoology, Australia
<b>Project Leader</b>	Dr Paul Southgate Phone: (07) 47815 737 Fax: (07) 47251 570 Email: paul.southgate@jcu.edu.au
<b>Collaborating Institutions</b>	Australian Volunteers International, Australia Ministry of Environment and Natural Resources Development, Kiribati WorldFish Center, Malaysia Ministry of Agriculture, Fisheries and Forestry, Fiji
<b>Project Budget</b>	\$728,961
<b>Project Duration</b>	01/01/1998 to 31/12/2005 (Project extended from 01/01/2001 to 31/12/2005)
<b>ACIAR Research Program Manager</b>	Mr Barney Smith

### **Project background and objectives**

The small island nations of the Pacific have limited opportunities for export trade. Only non-perishable or high value products are feasible due to their remoteness. The production of black pearl and cultured mother-of-pearl shell have become important industries in some Pacific nations. In French Polynesia the black pearl industry is now their major export earner, with over 2,800 kg of cultured black pearls worth an estimated AUD164 million produced in 1994. The Cook Islands are also producing black pearls, earning AUD5.25 million in the mid 1990s. Many Pacific island countries, particularly those that are atoll-based, have a strong interest in the development of national pearl oyster culture industries, with several now actively working towards this goal. This is a major priority of the government of Kiribati, along with the Solomon Islands, Fiji and the Cook Islands.

This project follows directly from a previous project that focused on the pearl oyster resources of Kiribati. During that project, which ran from 1993 to 1996, the natural stock of pearl oysters in Kiribati and Fiji was assessed, along with the rates of spatfall of blacklip pearl oysters in the atoll lagoons of Kiribati. Low technology methods for hatchery and nursery culture of the oysters were developed to allow replenishment of natural oyster stocks. Finally practices to improve gem quality of pearls were investigated. Culturing black pearl oysters to establish an industry will help raise the quality of life of people living in the Pacific atoll islands where there are few potential sources of income or employment. The key elements to achieve this for blacklip pearl oysters are:

- further developing and refining hatchery culture techniques,
- investigating nursery and growout technology for use in the atolls and open reef systems of Kiribati and other Pacific nations,
- examining the rate of spat collection in areas of Fiji to determine the growth rate of spat/individuals under culture conditions,
- producing a simplified manual on the mariculture methods developed, and
- developing an appropriate business plan for the establishment of the industry in Kiribati.

### **Project progress**

#### **Year 7 (01/01/2004-31/12/2004)**

*Development towards a cultured pearl industry:* Cultured pearls were harvested in Kiribati in 2003 when other oysters were enucleated for pearl production. The latter will be harvested for pearls during 2005. Further enucleation for pearl production took place in September 2004. An experimental cultured pearl farm has been established at Tebunginako at Abaiang atoll. Approximately 2000 pearl oysters are housed at the farm, which is maintained by locals previously trained in pearl oyster culture methods.

Longlines were established at Abemama, Butaritari and Onotoa in mid-2003. Pearl oysters were deployed to Butaritari and Onotoa at the end of June 2003 and to Abemama in September 2003.

Each of the three islands has a 60 m longline (Butaritari has 2 lines) holding between 4,000-5,000 oysters. Growth rates of oysters at Butaritari and Onotoa have been excellent. Oysters were deployed with a dorso-ventral height (shell length) of 5-8 mm. By early 2004, they had reached 50-60 mm in shell length.

A draft Cultured Pearl Industry Management and Development Plan for the period 2001-2004 was completed via the Pearl Oyster Coordinating Committee (POCC) during 2003. The POCC has been approved by Cabinet and will provide advice to the Minister on the development of a cultured pearl industry in Kiribati. The Plan will be updated for the period 2005-2010 during the final year of the Project (2005). A workshop focused on "Pearl Oyster Economics" was held in Kiribati in September 2004 with support from SPC. It provided input from experts from SPC, Cook Islands and FSM as well as expertise from Project personnel.

*Produce P. margaritifera spat through hatchery culture in Tonga:* A hatchery run was undertaken in Tonga in November/December 2003. Unfortunately, water temperatures at this time did not exceed 24-25°C, which is the minimum required for development of *P. margaritifera* larvae. As a result of the low temperatures, larval development was extremely slow and larvae had not developed to the eyed stage (settlement stage) after 40 days. It is recommended that future larval culture activities in Tonga take place in January or February when more appropriate water temperatures are likely to exist. These activities provided an excellent opportunity for training of Tongan Fisheries staff and members of the Tonga Pearl Growers' Association. Given the extended larval culture period, a significant amount of training was provided in the areas of larval husbandry, microalgae culture and settlement of *P. margaritifera* larvae.

*Produce up to date culture manual for P. margaritifera:* Literature relating to pearl quality and oyster cultivation has been gathered from Polynesia and other sources. It has also been gathered from sources within SPC with their assistance. Some of this information was translated (from French) during 2004 and all information was used to update the Culture Manual during 2004. A final draft of the Culture Manual will be completed in early 2005.

*Develop various scenarios for transition towards industry development:* An ACIAR/SPC Black Pearl Culture Workshop was held in November 2004 in Tarawa. It investigated economic models relating to the development of pearl culture in Kiribati and ran a number of financial simulations using the SPC spreadsheet based pearl culture economic model.

*Economic modelling:* Economic models, particularly sensitive to certain variables such as pearl price, cost of seeding and labour, were used to support consideration of development options for Kiribati. The simulations are useful to inform the policy discussion on which models of pearl farming operations are likely to succeed and as an initial guide to potential investors. Three farm sizes were examined, small (5,000 oysters), medium (30,000 oysters) and large (100,000 oysters). The modelling suggested:

In relation to farm size, the economic modelling suggested a small private sector (5,000 oysters) integrated operation culturing round pearls from spat is relatively high risk. The range of profitable round pearl culture operations is between 30-100,000 oysters with diminishing risk as the number of oysters cultured increases. Generally higher risk becomes more acceptable if potential returns are higher.

Production of three major products, oyster shell, half pearl (mabe) and round pearl were modelled, suggesting generally larger farms approaching 100,000 oysters will be more profitable focusing on round pearls rather than mabe, or production of oysters for seeding by a third party. A medium-sized private sector farm (30,000 oysters) growing oysters from spat and selling-on for seeding by another pearl farming operation was relatively low risk and provided a good return, but was conditional on a market for oysters ready for seeding. A medium-sized farm growing oysters is likely to be more profitable, if the oysters are retained and seeded for mabe production, but with a slightly higher risk. A medium-sized farm only culturing mabe pearls has a good probability of being profitable.

The economic modelling suggested that community farms may accept lower levels of profit, recognising the overall benefit to the community (employment, family structures, etc.). Community level farms may also have lower costs of production, due to low labour costs, but are likely to be less efficient than a private farm. The community farm model assumes lower start-up capital costs due to fund-raising opportunities (including from donors).

*Management Issues:* Findings relating to management issues include:

- Island Councils that generally control lagoon management mean high levels of assistance from central government will be required to establish lagoon management framework. Island Councils may be the best authority for allocation of farm sites with support from government,
- kick-start funding will be need to establish the pearl industry,
- at least initially, the hatchery should be government controlled, but may be operated privately. This will promote orderly development of the pearl industry and revenue from spat sales will provide funds for technical advice to pearl farmers. Both inputs (spat) and outputs (export pearls) may be controlled by government. There are some advantages to this, although this approach goes against the market principles promoted by ADB and others, and may not be economically efficient in the long term,
- marketing risks (i.e. ability to sell pearls) can be minimised by focusing on high quality pearls, finding a niche product (e.g. coconut/pearl jewellery and high quality half pearls (mabe) and the tourist market),
- the most profitable round pearl farm runs with 100,000 or more oysters, requiring a capital investment of around \$250,000, and
- this model production is much less technical than round pearl production and a seeding technician is not required.

The Pearl Economics Workshop in November 2004 assessed the potential for production of half pearls (mabe) in Kiribati. Estimates using the SPC pearl economic model indicated that mabe production would be a low risk and profitable option for pearl culture in Kiribati and one suitable for family or community based operations. On this basis, the current extension will assess mabe production at Abaiang and Kiritimati Island. The latter is well known for good coloured nacre.

A large proportion of cultured round pearls are of low non-commercial value and this was the case with the first pearl harvest from Kiribati. In Polynesia, lower grade pearls have been used in jewellery items made from local materials such as coconut fibre. There is a good market for such items which offer a means of generating income from pearls with limited or no commercial value.

*Continue production of cultured round pearls and trial production of half pearls:* A professional pearl seeder was used for the third pearl seeding took place in November 2004 with very good results. This background proved ideal for seeding in Kiribati and for transfer of information and capacity building. The seeding in November 2004 resulted in 4,217 seeded oysters. The pearl seeder commented on the unique nacre colour of some of the oysters in Kiribati which she had not seen in 20-25 years of pearl seeding. Such colours included “fancy golden peach and apricot tones” and provides an opportunity for Kiribati in terms of niche marketing.

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

<b>Overseas Collaborating Countries</b>	Fiji, Kiribati, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu
<b>Commissioned Organisation</b>	Queensland Department of Primary Industries and Fisheries, Australia
<b>Project Leader</b>	Dr Mike Rimmer Phone: 07 4035 0109 Fax: 07 4035 6703 Email: Mike.Rimmer@dpi.qld.gov.au
<b>Collaborating Institutions</b>	Secretariat of the Pacific Community, New Caledonia WorldFish Center, New Caledonia
<b>Project Budget</b>	\$762,855
<b>Project Duration</b>	01/01/2004 to 31/12/2006
<b>ACIAR Research Program Manager</b>	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 seacucumber, 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 1 (01/01/2004-31/12/2004)**

*Mini-projects:* During the first year, four mini-projects were approved and funded. Two have commenced, the others will start in 2005:

- *Confirmatory testing of the viral status of Penaeus monodon (black tiger shrimp) populations in the Fiji Islands.* This small miniproject commenced in June 2004 and was due to finish in November 2004 but has been extended to February 2005. An interim report is presented in Appendix 1.
- *Development of commercial and farm-made feeds for tilapia and macrobrachium in PNG and Fiji.* This project is a large miniproject which commenced in December 2004 and is due to finish in August 2006.

- *Monoculture of the freshwater prawn, Macrobrachium lar, in Vanuatu and integrated prawn-taro farming in Wallis & Futuna.* This small miniproject is due to commence in February 2005 and run for approximately six months.
- *Rehabilitation of the mariculture research facility at Motupore Island Research Centre, Papua New Guinea.* This small miniproject is also due to commence in February 2005 and be completed by April 2005.

*Capture and culture of pre-settlement coral reef fishes and invertebrates:* This component of the project is continuing the activities of a related ACIAR project developing new artisanal fisheries based on the capture and culture of postlarval coral reef fish (referred to as PCC), using WorldFish staff based at the Nusa Tupe Field Station, Solomon Islands. In June a workshop to train village participants and National Fisheries Officers in PCC techniques was held at Nusa Tupe. As a result of the training received, community members from two Western Province villages began catching and rearing post-larval lobster, cleaner shrimp and fish. Several shipments have been made to the Honiara-based aquarium fish exporter between October and December, generating income of SB\$3,750 (approx. AU\$750).

In November the project team visited the towns of Buala and Kia in Isabel Province to raise awareness and gauge interest in transferring the technology to another area in Solomon Islands. As a result of the presentation given at the Fourth Heads of Fisheries Meeting in Noumea in August 2004 several Pacific countries have expressed an interest in adopting the PCC technology. Progress was made in the preparation of a simple methods manual for the techniques. A Solomon Island artist has been engaged and a number of draft illustrations submitted.

*Sea cucumber aquaculture/reseeding:* Sandfish (*Holothuria scabra*) hatchery production is being undertaken at the hatchery facility of QLD DPI&F Northern Fisheries Centre, Cairns. Initially, only broodstock acquisition and maintenance was scheduled for the first year of the project. However, two successful hatchery runs were also completed in late 2004, which brought forward the production aspect of this component.

Broodstock were purchased from the Nunukul Ngugi Cultural Heritage Corporation of Stradbroke Island who operate a developmental fishery in Moreton Bay. In May 2004, 123 mature sandfish were transferred to a pond at DPI&F Oonoonba Veterinary Laboratory (OVL). In order to compare the performance of different ponds with respect to broodstock maintenance, 60 sandfish were moved to a commercial shrimp pond in July 2004. In late 2004, 47 sandfish remained in the OVL pond and were used for hatchery production.

## **Project FIS/2001/085: Integration of broodstock replenishment with community-based management to restore trochus fisheries**

<b>Overseas Collaborating Countries</b>	Samoa, Vanuatu
<b>Commissioned Organisation</b>	Kimberley Aquaculture Aboriginal Corporation, Australia
<b>Project Leader</b>	Dr Chan Lee Phone: 03 9670 0354 (in Vic), 08 9193 7138 (in WA) Fax: 03 9670 0354 (in Vic), 08 9193 3175 (in WA) Email: clee8777@bigpond.net.au
<b>Collaborating Institutions</b>	Department of Agriculture, Forests, Fisheries and Meteorology, Samoa Fisheries Department, Vanuatu Department of Fisheries, Western Australia, Australia
<b>Project Budget</b>	\$396,863
<b>Project Duration</b>	01/07/2002 to 30/06/2005
<b>ACIAR Research Program Manager</b>	Mr Barney Smith

### **Project background and objectives**

The marine topshell *Trochus niloticus*, commonly called trochus, is a large conical-shaped herbivorous marine snail that occurs on shallow tropical reefs in the Indo-Pacific region. It is sought after for its shell, which possesses a thick mother-of-pearl layer that makes it useful for making buttons, inlays and ornaments. Trochus is an economically valuable resource for indigenous and artisanal fishers in the Indo-Pacific region. Since the 1920s, the species has been translocated to almost every island group in the Pacific Ocean. This extensive translocation has resulted in the establishment of substantial fisheries in many locations. However, the translocations did not always result in stock enhancement and sometimes had low success rates.

Research on the effectiveness of strategies for restocking trochus has indicated that it is feasible to use broodstock seeding as a tool to re-establish stocks on depleted sites or suitable sites where trochus are absent. To enhance the outcome and to ensure the success of broodstock stocking, community involvement is essential, operating in tandem with community-based management strategies such as customary marine tenure (CMT) (in Vanuatu), village based fisheries management (in Samoa), and cooperative management arrangements involving traditional owners in the Kimberley (Australia).

The project is using broodstock seeding in tandem with community-based management strategies to facilitate the establishment of effective breeding populations of trochus on depleted reefs in Australia (Kimberley), Samoa and Vanuatu. The ultimate goal is to provide a simple framework that allows the responsible agencies to implement a nationally coordinated and strategic stock management plan for establishing sustainable trochus fisheries through broodstock reseeding, the application of CMT and/or the establishment of marine protected areas (MPAs).

### **Project progress**

#### **Year 3 (01/07/2004-30/06/2005)**

*Establish a framework for community consultation and involvement in enhancement activities:* Participation by communities in the decision making processes prior to the commencement of the project helped establish dialogues with the communities involved prior to finalising the sites for the seeding work. On-going close contacts during the three-year seeding work involving interaction, dissemination of information, communication, and negotiation with the communities involved to finalise the establishment of Marine Protected Areas (MPAs) was undertaken. In Samoa project work was carried out in existing MPAs, with MPAs established in all seeding sites in the three countries involved. Whilst the Pacific island nations are familiar with the application of CMT and MPAs for coastal resources management, this is the first time an indigenous group in Australia have participated and fostered the establishment of MPAs to protect their natural resources.

*Stock enhancement on selected reefs:* Ten trochus density surveys (1 pre-enhancement and 9 post enhancement) were conducted, in juvenile and adult habitats, between August 2003 and March 2005. Smaller trochus occurred on the reef flat (juvenile habitat) compared with the reef edge (adult habitat). The skewed results of the size distribution of trochus in adult habitats suggests that the principal mechanism for recruitment is migration of adult trochus rather than larval settlement. The results clearly indicated that MPAs are highly effective in protecting and enhancing the existing trochus fishery. The efficacy of MPAs is likely to be assisted on reefs where sufficient numbers of adult broodstock and favourable currents, result in good levels of intrinsic recruitment. Additionally, in the Kimberley, where very strong tidal currents occur, extrinsic recruitment may effects trochus densities on adjacent reefs. Hence, the location of MPAs should take into consideration the possible impacts of both intrinsic and extrinsic recruitment.

MPAs established in juvenile habitats can improve the density of adult trochus in adult habitats, if the areas are closed for sufficiently long periods that allow the carrying capacity of juvenile areas to be met, allowing migration to occur.

In Samoa whilst spawnings are likely to have occurred in seeded site, it is too early to observe successful recruitment. Previous experience in the Pacific indicates that the full impact of broodstock enhancement is likely to be apparent only after five years or more.

*Capacity building of participating staff:* Ongoing support has been provided, on request, to the Samoan and Vanuatu nodes of the project in field survey techniques, site selection, data analyses and interpretation, and hatchery activities. Additionally, all nodes applied the concept of using Community Coordinators as the focal point for training and interactions between project staff and communities. The capacity of Community Coordinators was strengthened and their understanding of the project work enhanced through this interaction.

*Hatchery work in Samoa:* The Samoan project team initiated the trochus spawning and hatchery work at the Toloa hatchery. The training was attended by seven Samoan staff and the first successful trochus spawning was achieved at the hatchery. Two other successful spawning trials were carried out in the Toloa Hatchery. In both spawning trials, females released eggs.

*In country and regional dissemination of outcomes:* Ongoing in-country dissemination of results continued during the course of field work. All three countries are briefing the communities involved in the project work through regular meetings and participation in the project field work. In the Australian node, KAAC disseminated project information via its quarterly KAAC Newsletter; the newsletter is available on its website: [www.kaac.org.au](http://www.kaac.org.au)

The regional dissemination of project outcomes has been accelerated with the preliminary results from the project reported in the SPC Trochus Bulletin, interactions between project staff and staff from the SPC Aquaculture project. The profile of some of the staff involved in the project was also highlighted in the SPC Trochus Bulletin.

## **Project 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**

<b>Overseas Collaborating Countries</b>	Papua New Guinea, Solomon Islands
<b>Commissioned Organisation</b>	James Cook University, School of Tropical Biology, Australia
<b>Project Leader</b>	Professor Roger Leakey Phone: 07 4042 1573 Fax: 07 4042 1319 Email: roger.leakey@jcu.edu.au
<b>Collaborating Institutions</b>	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
<b>Project Budget</b>	\$203,606
<b>Project Duration</b>	01/07/2004 to 30/09/2005 (Project extended from 01/07/2005 to 30/09/2005)
<b>ACIAR Research Program Manager</b>	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 will focus 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 will also be examined.

The project is determining 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.

### **Project progress**

#### **Year 1 (01/07/2004-30/06/2005)**

The Feasibility Project identified that *Canarium* nuts are a high value, nutritious, premium product, with good processing attributes (drying, roasting, salting, etc.). Extracted kernels have a soft texture which is popular and allows a broad range of uses in confectionary/baking. The edible kernels are associated with healthy living in Melanesia. There are considerable opportunities for domestication, which would overcome the 'supply issues' that have caused the failure of earlier attempts to commercialise the kernels. These opportunities are enhanced by large tree-to-tree variability in key kernel traits available for cultivar selection. The likely success of domestication and commercialisation is enhanced by building on traditional use, existing markets and recognised livelihood benefits.

Attitudes and perceptions of communities and consumers towards indigenous fruits and nuts in the household food intake and in landuse were:

- all rural households use Galip for food, 80 per cent as a source of cash and 50 per cent for bartering. Cash is mostly used to buy food. Galip is the preferred species (55-75 per cent) of nut for food and for income generation,
- sixty per cent of nationals and expats eat fresh raw Galip kernels, another 20-25 per cent eat dried kernels. Processed (roasted) kernels are not readily available, but about 10 per cent mentioned consuming them. Galip was preferred above all other species of indigenous and exotic nuts. Most (70-90 per cent) respondents recognised Galip as a healthy product, 60 per cent of respondents would like to be able to buy more Galip. Urban markets are willing to pay higher prices, and
- fifty to seventy per cent of farmers would like to grow more Galip, mostly (55-65 per cent) for their income generating potential, especially in areas close to markets. In remote areas, food was the main reason given for growing more. 80-90 per cent of farmers recognised potential to improve kernel size and taste through domestication.

Potential opportunities and constraints for domestication and commercialisation are:

- market confidence (both regional and export) satisfying local demand first;
- semi-processing shows great promise, with cracking of nuts in villages (to provide employment to women) and drying and packaging of kernels done centrally. Processing must include; traceability to origin, and preparation to food safety certification standards and good manufacturing practices;
- training is needed at the village level on post harvest techniques to ensure product safety for certification and quality;
- Significant job creation and rural income streams are achievable with proper industry development, based on nucleus estates in key provinces to provide a 'Commercial Hub'; and.
- Consumer acceptability was assessed by sensory analysis. Roasted kernels were scored highest. Average score was 57 per cent, which was lower than four commercial nut species (macadamia, cashew, pecan and peanuts), which scored 76-85 per cent. Fresh kernels were not tested. The drying process seemed to have detrimental effects on flavour.

The principle selection criteria for domestication were identified as: kernel mass, kernel/nut ratio, taste, ease of cracking and seasonality of production. Analysis of kernels from 18 Galip trees revealed tree-to-tree variation of 67-75 per cent in fat/oil content, 11.2-13.6 per cent in protein, 5.7-11.4 per cent in carbohydrate, 15.3-197mg/kg in sodium and energy content of 2896-3086kJ/100g. Kernel drying has to occur within 24 hours of cracking the nuts if quality is to be retained. Dried kernels can be stored in polythene containers for a few months, and in glass containers for a few years. Vacuum packing causes oil leakage. Opportunities for year-round production in Melanesia suggest that the development of a 'Melanesian Supply Chain' offers the most potential for longer term industry development, with maximum benefits for village communities.

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

<b>Overseas Collaborating Countries</b>	Vanuatu
<b>Commissioned Organisation</b>	James Cook University, School of Tropical Biology, Australia
<b>Project Leader</b>	Professor Roger Leakey Phone: 07 4042 1573 Fax: 07 4042 1319 Email: roger.leakey@jcu.edu.au
<b>Collaborating Institutions</b>	Queensland Forest Research Institute, Australia Queensland Department of State Development, Australia Department of Forests, Vanuatu
<b>Project Budget</b>	\$722,502
<b>Project Duration</b>	01/07/2004 to 30/06/2007
<b>ACIAR Research Program Manager</b>	Dr Russell Haines

### **Project background and objectives**

Sandalwood oil, produced from the heartwood of sandalwood trees is a valuable commodity. The aromatic oil is widely used in perfumery, medicines and incense joss-sticks. The sandalwood tree (genus *Santalum*) occurs throughout South and Southeast Asia, Australia and the Pacific. All are hemi-parasitic on a wide-range of species. Demand for sandalwood oil continues to rise, but over-exploitation of the natural resource base has led to a worldwide shortage.

In Vanuatu sandalwood is found on the western parts of seven islands, the largest quantities on Santo and Erromango. Almost all these trees are of wild origin. Forestry is a vital industry in Vanuatu, with sandalwood royalties accounting for almost half of that paid for all timber species. Most growers on Erromango have small 'garden' plantings of between five and 10 trees as an income supplement. A different sandalwood species has been cultivated for oil, food, fibre and medicinal purposes by Aboriginal communities on Cape York Peninsula. Common problems for both communities are a lack of information and management techniques. In both locations reseedling of improved stock is needed. Increasing information on native forest management, tree improvement, silvicultural systems, value adding and utilisation are all barriers to producing more oil. Morphological characteristics such as variations in oil yields and quality are also poorly understood. Focusing research on these areas is central to this project which is working to stimulate the development of the emerging sandalwood oil industry, through the genetic improvement of the planted resource of *S. austrocaledonicum* in Vanuatu, and *S. lanceolatum* in Queensland.

### **Project progress**

#### **Year 1 (01/07/2004-30/06/2005)**

The main field activities over the past six months have been the completion of sample collecting for 25 additional sandalwood trees in Delta Downs, Cape York. Tree data and samples were collected along with information relevant to the associated vegetation, soil type, regeneration and morphological characteristics for every tree sampled to assist in the characterisation of variation between trees and sites.

Wood core samples collected in 2004 in Vanuatu and Cape York have been chemically analysed. This revealed a significant variation within and between populations for all morphological characters measured for both species. Oil yields as estimated using an internal standard were substantially lower than found by industry when extracting oil by distillation. Directly comparing oil yields of a given sample between solvent extraction and water distillation will clarify this difference.

The continuous variation found for all major oil constituents, means there is no chemotype division in *S. austrocaledonicum* as previously reported for this species [Ehrhart, 1998 #3373]. The populations from the two northern islands (Santo & Malekula) have a greater proportion of trees with high values for the commercially important oil constituents (santalols) than the populations sampled from the southern islands. This broad geographical variation overlaid further significant tree-to-tree variation in

oil constituents within each population, whereby each population had a range of trees with high and low quality as compared with the international standard for sandalwood oil. No correlation has been found between any of the morphological or ecological characters and the important oil-constituents. This information does not support current perceptions that heartwood colour is an indicator of oil quality.

Genetic fingerprinting has been undertaken on three of the Vanuatu populations (Santo, Malekula & Erromango). Genetically Santo and Malekula are quite similar and each clearly distinct from genotypes of Erromango. Erromango exhibits considerable tree-to-tree genetic variation across all five loci screened, however a high level of relatedness was found among the individuals from Santo & Malekula. Many of the individuals with high oil quality in the northern islands are related and could be considered siblings or the result of self-pollination. This has important implications for both the conservation of these populations and also the domestication programme.

Also evident during the field collections is the threatened state of the current sandalwood resource in Vanuatu. In all islands except Erromango it was difficult to locate 25 trees within a single site, even with the assistance of villagers that have intimate knowledge of their lands. Although there are significant resources still remaining in Erromango the harvesting pressure is very acute.

Significant variation was also found for all morphological characters measured within and between populations of Cape York sandalwood (*S. lanceolatum*). The indigenous participants have requested that at this stage the identity of the sites be kept confidential to ensure that intellectual property is protected. Oil samples from Cape York were generally much higher in nuciferol and curcumenol than those of Vanuatu, which confirms existing knowledge of the oil profile of *S. lanceolatum*. The growth rate of *S. lanceolatum* in such environments is important and current work is looking to quantify growth potentials in Cape York. Acacia's were the main associated species in each of the populations evaluated, but no associated putative host species had an effect on any of the morphological or oil characters measured. Therefore future selection for oil characteristics can be undertaken independently of any host associations. Relationships between host and sandalwood growth rates are an important consideration in its production in agroforestry and will be undertaken during the host x genotype interaction experiment.

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

<b>Overseas Collaborating Countries</b>	Papua New Guinea, Solomon Islands
<b>Commissioned Organisation</b>	Australian National University, School of Resources, Environment and Society, Australia
<b>Project Leader</b>	Dr Ryde James Phone: 02 6125 4330 Fax: 02 6125 0746 Email: ryde.james@anu.edu.au
<b>Collaborating Institutions</b>	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
<b>Project Budget</b>	\$149,989
<b>Project Duration</b>	01/04/2005 to 30/09/2006
<b>ACIAR Research Program Manager</b>	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 7,000 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 to 31/03/2006)**

The first progress report is due in 2006.

## **Project LPS/2003/054: Feeding village poultry in the Solomon Islands**

<b>Overseas Collaborating Countries</b>	Solomon Islands
<b>Commissioned Organisation</b>	South Australian Research and Development Institute, Pig and Poultry Production Institute, Australia
<b>Project Leader</b>	Dr Phil Glatz Phone: 08 8303 7786 Fax: 08 8303 7689 Email: glatz.phil@saugov.sa.gov.au
<b>Collaborating Institutions</b>	Kastom Gaden Association, Solomon Islands Department of Agriculture and Livestock, Solomon Islands National Agricultural Research Institute, Papua New Guinea
<b>Project Budget</b>	\$399,990
<b>Project Duration</b>	01/01/2005 to 31/12/2007
<b>ACIAR Research Program Manager</b>	Dr Bill Winter

### **Project background and objectives**

Village poultry are a vital source of food security and, in many cases, supplemental income for smallholder farmers. In Solomon Islands an estimated 22,000 families have poultry, producing 210,000 birds and 2.64 million eggs a year. Both live birds and eggs are sold, usually in local markets. Poultry production by village families has considerable scope for improvement. Only one bird is consumed on average each month along with some eggs, with this likely to vary given other enterprises and income streams. An average of 30 per cent of infants are underweight with malnutrition the cause, despite an available source of protein and nutrition through eggs and birds. Two main barriers exist to increased production: better feeds and the size of the average family's flock.

Kastom Gaden Association (KGA), a local NGO, estimates that between 20 and 40 chickens per family would allow eggs to be eaten and sold each day as well as a regular consumption of chicken meat. Existing feeding systems, however, limit the number of chickens that can be run. This is despite a wide variety of local feed resources being available, including root crops, fruit and native plants. Identifying feeds for village chickens that would result in a higher nutritional intake and more cost effective poultry systems will produce more birds and eggs. This will boost income and begin to change the current system, ensuring more chickens are run and families see greater financial and dietary returns. The project is developing improved systems of village-based poultry production, through:

- identifying rations for village-based layer and meat birds based on locally available feedstuffs,
- interacting with farmers and farmer groups to evaluate, disseminate and communicate the value of rations based on local feedstuffs.

### **Project progress**

#### **Year 1 (01/01/2005 to 31/12/2005)**

The first progress report is due in early 2006.

## **Project LWR/2001/050: Equitable groundwater management for the development of atolls and small islands**

<b>Overseas Collaborating Countries</b>	Kiribati, Tonga
<b>Commissioned Organisation</b>	Australian National University, Centre for Resource and Environmental Studies, Australia
<b>Project Leader</b>	Professor Ian White Phone: 02 6125 0660, 02 6125 3033 Fax: 02 6125 0757 Email: <a href="mailto:ian.white@anu.edu.au">ian.white@anu.edu.au</a> <a href="http://cres.anu.edu.au/">http://cres.anu.edu.au/</a>
<b>Project Web Site</b>	<a href="http://cres.anu.edu.au/">http://cres.anu.edu.au/</a>
<b>Collaborating Institutions</b>	South Pacific Applied Geosciences Commission, Fiji Tonga Water Board, Tonga Ministry of Works and Energy, Kiribati Ministry of Lands, Survey & Natural Resources, Tonga Ministry of Agriculture and Forestry, Tonga Ecowise Environmental Pty Ltd, Australia Department of Agriculture, Kiribati
<b>Project Budget</b>	\$394,318
<b>Project Duration</b>	01/07/2002 to 31/12/2005 (Project extended from 01/07/2004 to 31/12/2005)
<b>ACIAR Research Program Manager</b>	Dr Ian Willett

### **Project background and objectives**

Groundwater is the main source of freshwater in many Pacific atolls and small islands. Its quality, management and allocation are central to sustainable development and poverty alleviation.

Kiribati and Tonga rely on agriculture for valuable export earnings and subsistence. Both countries have major water resource limitations. Surface water is constrained by limited land area, permeable soils and high evaporation rates. Groundwater is therefore of critical importance, especially during drought. However, groundwater is vulnerable to seawater intrusion and subsequent mixing with this saline water, along with inputs from agriculture and increasing demand. There are also issues to do with land ownership and water use regulation.

This project is helping atolls and small islands to establish more sustainable and equitable mechanisms for the use of groundwater. In particular, it will provide guidelines for the management of groundwater and irrigated cropping to protect groundwater, improve resource security for cropping, sustain development and decrease conflicts over water.

### **Project progress**

#### **Year 2 (01/04/2004-31/03/2005)**

In low coral atolls, groundwater exists as freshwater lenses floating over saline transition zones, grading into seawater. To lessen the risk of seawater intrusion, groundwater is pumped from long, horizontal, infiltration galleries. Population growth, limited land, human activities including agriculture and frequent droughts place groundwater under stress.

Tarawa atoll has two regions, heavily populated, urbanised South Tarawa and sparsely populated rural North Tarawa. In the low islands studied in Tarawa, Bonriki and Buota in South Tarawa, currently used for groundwater extraction, and the undeveloped Abatao and Tabiteua in North Tarawa, the spatial extents of their groundwater lenses have now been measured. These measurements permitted waterbalance estimates, using the highly variable climate record, of their sustainable pumping yields of fresh groundwater. Potential sites for additional galleries were identified.

A critical concern in small island communities with land overlying fresh groundwater stores is the impact of groundwater pumping on traditional crops such as swamp taro and coconuts. On Bonriki,

the community attributes a general decline in productivity of coconuts to groundwater pumping. An extensive study was conducted of shallow groundwater drawdown and salinity by pumping from all infiltration galleries on Bonriki and Buota. This found the mean drawn down due to pumping was close to the theoretically predicted drawdown. This was an order of magnitude less than diurnal tidal fluctuations of groundwater that coconut tree roots are exposed to. Pumping also had a negligible influence on groundwater salinity. A theoretical study of the width of the saline transition zone beneath the freshwater lens estimated pumping increased its width by 37 per cent but the frequent El Niño droughts increase the transition zone width by 90 per cent. Examination of the sparse coconut trees at Bonriki and a review of their physiology indicate declines in productivity are due to senescence (aging) and lack of crop management.

Because of the scarcity of land on small islands, agricultural activities, such as market gardens and swamp taro production, often encroach over shallow groundwater reserves. The use of animal manures and inorganic fertilisers, construction of open wells for watering and increased cropping density of coconut trees have raised concern over impacts on groundwater. Extensive sampling of groundwater on Bonriki revealed E. Coli and elevated nitrate and dissolved organic carbon levels in areas with market gardens and abandoned swamp taro pits. Large concentrations of hydrogen sulphide were also found due to reduction of sulphate in groundwater. Chlorination and air sparging removes these materials.

A water balance model was used to examine impacts of coconut tree density on groundwater recharge. Tree density had little influence during major wet periods. During droughts, however, it has a major impact causing significant periods of net groundwater loss. Predictions are consistent with measured groundwater salinity records. Analyses of the drought impact on the thickness and salinity of the freshwater lens predicted watertable falls of up to 400 mm during prolonged droughts, close to the measured decrease of 440 mm. Predicted increases in salinity of the freshwater lens are consistent with observed increases and measured saltwater intrusion. The nonparametric method of identifying droughts can provide a lead time of about three months warning of droughts.

Local and expert knowledge on groundwater and water supply has been collected and this has been incorporated with the hydrology and salinity dynamics into a Multi-Agent System for groundwater use and management, AtollScape. The system includes all the principal actors in water extraction and use, down to households. A role playing game, AtollGame to explore different scenarios through use of AtollScape and reduce conflicts has been developed. A two-day trial of the game with relevant representatives from the islands of Abatao and Tabiteua and key government stakeholders produced a flow chart of financial, technical and social solutions and a proposal for a sequential refining of the process to arrive at equitable management options.

## **Project PHT/2001/023: Horticulture industry development for market-remote communities**

<b>Overseas Collaborating Countries</b>	Samoa
<b>Commissioned Organisation</b>	Queensland Department of Primary Industries and Fisheries, Australia
<b>Project Leader</b>	Mr Rowland Holmes Phone: 0747830409 Fax: 0747833193 Email: Rowland.Holmes@dpi.qld.gov.au
<b>Collaborating Institutions</b>	Ministry of Agriculture, Forests, Fisheries and Meteorology, Crops Division, Samoa
<b>Project Budget</b>	\$399,559
<b>Project Duration</b>	01/07/2003 to 31/12/2006 (Project extended from 01/07/2006 to 31/12/2006)
<b>ACIAR Research Program Manager</b>	Dr Greg Johnson

### **Project background and objectives**

Remote tropical communities undertaking horticultural activities must carefully choose what enterprises they invest in, with this decision including reference to the distance of these communities to markets. Where infrastructure is poor or non-existent only produce with a longer shelf life and good chance of surviving to market can be grown. Perishable commodities will not survive and reduce or destroy profitability. Technical research has made advances in improving both pre and post harvest management of a variety of horticultural produce. Many of these impact positively on shelf life, making up for under-developed supply chains and also enhancing development of these chains. Quality management systems are of great importance, generating improved practices and efficiencies throughout the supply chain.

Information packages are the key to delivering these improvements, and to the industry's long-term sustainability. Remote communities in Samoa and Cape York Peninsula in Australia stand to benefit from information to influence choices of what fruit to grow and how to deliver improvements to the supply chain. Aboriginal communities in Cape York make decisions on land use through locally elected councils and by the traditional owners of the land, influenced by their elders. In Samoa the 'Matai' system of community ownership and family headship makes it imperative to have information on options available. Family heads make decisions that apply to community land, making it necessary for individual farmers to work with and within this context. A decision that does not cater to infrastructure, supply chains and other realities can significantly hamper even the most efficient individual producers in both Samoan and Australian communities. Fostering the sustainable development of horticulture to supply local and distant markets (in Samoa and Cape York Peninsula) is being achieved by enhancing capacity for the development and use of technical information by researchers, extension personnel and farmers.

### **Project progress**

#### **Year 2 (01/07/2004 to 30/06/2005)**

*Research information use and needs:* A series of interviews and several participatory rural appraisals have been conducted with the target groups in Samoa. The main issues raised by Taro growers during the interviews were the identification of new varieties and managing and identifying pests and diseases without the excessive use of chemical pesticides. Papaya growers wanted more information on growing, husbandry, harvesting and grading standards for papaya as well marketing information such as identifying export markets and price.

Issues relating to packaging and labelling were the main concern for Agro-processors. Finding and accessing information on CODEX and food safety was also an issue for this target group. Overnight storage of produce and maintaining quality and shelf life of produce were the main issues for the Roadside stallers. The need for better record keeping has also been identified to help stallers access financial assistance to develop their businesses.

A series of informal interviews have been conducted with a wide cross section of the Mapoon Aboriginal community in Queensland and the key personnel involved with the community farm at Napranum. These interviews have helped define their interests in horticulture (both growing and using) and identifying information sources within the community and those external to the community. Interviews, focus groups and farm visits have been held with commercial growers in the Cooktown area. The needs to customise a wide range of horticultural information to take advantage of unique market windows and reduce the impact of the harsh environmental growing conditions were the main issues identified by growers.

*Develop information strategy:* An information strategy is currently being developed using the concept of "Agricultural Knowledge and Information Systems" (AKIS). Using AKIS, the project team is mapping the "Information supply chains" used by specific target groups, to identify the key information sources, providers and repositories and to investigate importance of the relationships in the dissemination and use of information.

A series of Peninsula garden notes, Native Food plants and Ornamental crop notes have been developed and distributed to target growers and communities in both Cape York and Samoa. In Samoa, a number of crop management notes covering papaya and taro have been produced and are currently being translated into Samoan for distribution. Taro variety sheets have been developed for 14 different varieties with a further 6 planned.

*Capacity development of extension staff (Samoa):* Training in the use of interviews and focus groups as social research methods has been conducted during project visits to Australia and Samoa. These research processes have been field tested and modified to help the project team identify the key issues in relation to the access and use of horticultural information relating to decision making.

A series of computer training workshops with Samoan project staff were conducted during Australian project team visits. Training focused on using Word and PowerPoint as publishing tools and creating document templates. Examples of horticultural information sources and systems have been heavily featured to help the project gain an understanding of how such information is accessed and used.

## **Project PHT/2003/046: Integrated control of powdery mildew and other disease, weed and insect problems in squash in Tonga and Australia**

<b>Overseas Collaborating Countries</b>	Tonga
<b>Commissioned Organisation</b>	University of Sydney, Faculty of Agriculture Food and Natural Resources, Australia
<b>Project Leader</b>	Dr Robyn McConchie Phone: 02 9351 4332 Fax: 02 9351 4172 Email: McConchieR@agric.usyd.edu.au
<b>Collaborating Institutions</b>	Ministry of Agriculture, Forestry and Food, Tonga Secretariat of the Pacific Community, Fiji
<b>Project Budget</b>	\$399,959
<b>Project Duration</b>	01/01/2005 to 30/06/2008
<b>ACIAR Research Program Manager</b>	Dr Greg Johnson

### **Project background and objectives**

Agriculture is a vital contributor to the economy of Tonga. It is the leading employer, foreign exchange earner and is essential to food security. The leading agricultural export is squash, earning \$10.8 million in 2002. Squash is quick and easy to grow with a clear market in exports to Japan. In recent times other export industries in the agriculture sector have suffered due to pest and disease problems, making squash even more vital. These disease and pest problems are now beginning to reach threatening levels in the squash sector too. Controls against pests and diseases have been less effective. In turn this has increased pesticide usage resulting in pesticide resistance emerging. The use of pesticides also has implications for Tonga's water supply which is particularly vulnerable to water borne pollutants. The prevalence of diseases and pests has reduced the industry by close to two-thirds, from 2000 active farmers in 1987 to an estimated 550 in 2003.

Powdery mildew is the main disease. Outbreaks defoliate crops, in turn making plants more vulnerable to silver leaf white fly, other viruses and weeds. Current fungicides against powdery mildew are unreliable with increasing resistance reported. Past ACIAR research has demonstrated the value of integrated approaches to controlling powdery mildew which are applicable to Tongan conditions. These, along with pest controls targeting white fly and disease controls against viruses found in squash, have the potential to significantly rehabilitate the industry. The sustainability of the Tongan squash industry is being addressed through improvements to integrated disease, pest and weed management, specifically to improve field-based crop protection and market quality of squash within a systems framework.

### **Project progress**

#### **Year 1 (01/01/2005 to 31/12/2005)**

The first progress report is due in 2006.

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

<b>Overseas Collaborating Countries</b>	Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Tuvalu, Vanuatu
<b>Commissioned Organisation</b>	La Trobe University, School of Economics, Australia
<b>Project Leader</b>	Dr John Kennedy Phone: 03 94792313 Fax: 03 94791654 Email: j.kennedy@latrobe.edu.au
<b>Project Web Site</b>	<a href="http://www.business.latrobe.edu.au/staffhp/jkennedy/ACIARTechPapers.htm">http://www.business.latrobe.edu.au/staffhp/jkennedy/ACIARTechPapers.htm</a>
<b>Collaborating Institutions</b>	University of Queensland, Australia Secretariat of the Pacific Community, New Caledonia Forum Fisheries Agency, Solomon Islands
<b>Project Budget</b>	\$577,585
<b>Project Duration</b>	01/01/2002 to 31/12/2005
<b>ACIAR Research Program Manager</b>	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.

### **Project progress**

#### **Year 3 (01/01/2004-31/12/2004)**

Distant water fishing nations such as Japan, USA, South Korea, Taiwan and China are interested in paying for access to stocks in the Exclusive Economic Zones of Pacific Island countries. The special problems of obtaining international agreement on efficient management of migratory fish have been recognized in the United Nations Fish Stocks Agreement, which came into force in 2001. This has led to the setting up of commissions to oversee the conservation and management of migratory stocks in various parts of the world's oceans. The commission for the region which is the focus of the project (Commission For the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific) was installed in December 2004. The formation of the Commission is likely to focus attention on the benefits of coordinated action by the Pacific Island countries to improve efficiency in managing stocks.

*Translating the computer code of the disaggregated bioeconomic tuna model from C++ to Visual Basic:* This translation was undertaken so as to modify the model to experiment with different model assumptions, such as modelling year to year changes in stocks over a 15-year period under alternative effort levels of harvesting fleets; and to be able to experiment with a faster optimising routine.

*Progress with the small highly aggregated bioeconomic model:* A basic version of the model was completed, incorporating an optimising routine. This is being developed to model decisions of distant water fishing nations on catch effort within the EEZ's of the Pacific Island countries in response to access charges set by these countries. To ensure feasible computing times to obtain solutions, a small highly aggregated model is required, with parameters which can be calibrated from test results from the larger model.

*Investigating data and methods for determining the cost of increasing fleet capacity over time as original capacity declines:* Data were collected and analysed on the distribution of ages, capacities and prices of Purse Seiner and Longline vessels from published reports and internet sites advertising asking prices for second-hand vessels. The results were documented in a working paper.

*Colour mapping on Microsoft Excel spreadsheets of the aggregation of variables such as fishing effort and catch across the 5 degree squares of the Western and Central Pacific Ocean, with calculation of subtotals inside and outside the combined EEZ's of the Pacific Island countries:* A spreadsheet program was written for display of the fishing effort data by fleet entered for the large disaggregated model in each five degree squares of the WCPO, differentiating squares by colour according to whether they were land, sea within the Pacific Island countries' EEZs, and sea outside the Pacific Island countries' EEZs. This is important for understanding the overall magnitude and distribution of the effort of different fleets in different runs of the model, and for displaying data on catch and effort across recent years from the Oceanic Fisheries Program database. The percentage of total catch outside and inside the Pacific Island countries' EEZs can be calculated.

## **Project SFS/2002/047: Trade liberalisation, agriculture and land degradation in Fiji: implications for sustainable development policies**

<b>Overseas Collaborating Countries</b>	Fiji
<b>Commissioned Organisation</b>	University of Queensland, Australia
<b>Project Leader</b>	Dr John Asafu-Adjaye Phone: 07 33656539 Fax: 07 33657299 Email: j.asafu-adjaye@economics.uq.edu.au
<b>Collaborating Institutions</b>	University of the South Pacific, Fiji Ministry of Finance and National Planning, Fiji Australian Bureau for Agricultural and Resource Economics, Australia
<b>Project Budget</b>	\$390,841
<b>Project Duration</b>	01/10/2003 to 30/09/2006
<b>ACIAR Research Program Manager</b>	Dr Simon Hearn

### **Project background and objectives**

Export oriented growth is a key to the sustainable long-term development of the Fijian economy. Much of this growth is expected in the medium-term, to come from agriculture, a sector where Fiji has comparative trade advantages. Agriculture has contributed the bulk of total exports and almost a fifth of GDP, but both these contributions are in decline. Trade liberalisation is driving some agricultural growth and could become an important driver of sustainable development. There is a danger that the impacts of increased production could harm Fiji's fragile ecosystem. Land degradation resulting from cultivation on steep slopes and marginal lands, combined with deforestation on these and other lands, are already causing problems. The availability and quality of freshwater is being affected and biodiversity is being lost. Land and sea-based pollution are also rising.

These are areas of concern for the Government but must be balanced against the potential for trade liberalisation to drive development. Policies are needed to strike this balance, ensuring benefits are gained from trade liberalisation while maintaining effective environmental resource conservation measures. Key institutions will be responsible for developing and implementing these policies, but have little experience in these areas. The project is assessing the economic and environmental impacts of agricultural trade liberalisation, as well as the agricultural production and trade effects of environmental changes, to propose measures to mitigate any adverse impacts.

### **Project progress**

#### **Year 2 (01/10/2004-30/09/2005)**

Project activities included completing the update of the Fiji Input-Output (I-O) model, developing an environmental module and collecting data for the environmental analysis aspect of the project. The following activities took place in this period:

A second field survey involving 400 farmers in Fiji was conducted. The questionnaires have been collated and entered into spreadsheets and are now being analysed. Work on updating the I-O database using 2002 socioeconomic data was completed. The work included splitting the informal sector into informal primary and secondary sectors.

The development of equations to represent the environmental component of the Fiji CGE model was also completed. The database update was reviewed and issues related to model testing and evaluation discussed and furthered. Substantial progress was made in terms of fixing bugs in the model and getting the prototype model to run. Further work remains to be done in terms of collecting additional economic and environmental data.

Two Working Papers have been published in this period and presentations are planned for next year's Australian Agricultural and Resource Economics and International Association of Agricultural Economists' conferences.

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

<b>Overseas Collaborating Countries</b>	Papua New Guinea, Tonga, Vanuatu
<b>Commissioned Organisation</b>	University of Queensland, The School of Land and Food Sciences, Australia
<b>Project Leader</b>	Dr Jane O'Sullivan Phone: 07 33654811 Fax: 07 33651188 Email: j.osullivan@mailbox.uq.edu.au
<b>Collaborating Institutions</b>	Ministry of Agriculture and Forestry, Tonga Department of Agriculture Livestock and Horticulture, Vanuatu National Agricultural Research Institute, Papua New Guinea
<b>Project Budget</b>	\$1,067,375
<b>Project Duration</b>	01/07/1999 to 31/07/2005 (Project extended from 01/01/2005 to 31/07/2005)
<b>ACIAR Research Program Manager</b>	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 5 (01/07/2005 to 30/06/2005)**

In Papua New Guinea, *Gliricidia* live-staking plots have been planted with yam for the third year in Dugumor, Madang Province, for a second year at Bubia Research Station and for the first season at Mutzing in the Markham Valley and in three villages on Kiriwina Island in the Trobriand group, Milne Bay Province. In addition, fertilizer rate trials were planted at Dugumor and on Kiriwina. At Tanam in the Markham Valley, an experiment is investigating zinc deficiency and possible remedies with both yam and maize. Mid season observations show that zinc deficiency was exacerbated by NPK fertilization, and ameliorated by either zinc application (soil-applied or foliar sprays) or chicken manure. Harvests are underway at the time of reporting.

In Vanuatu, the phosphorus rate trial at Malo was harvested in August, and replanted for a second year, this time with potassium applied to two replicates. A small P response was measured, but K response was not evident. At Tagabe Research Station, parallel experiments compared the response of *Dioscorea alata*, *D. rotundata* and sweetpotato to N, P and K applications, but no responses were evident. At VARTC, the growth and development of *D. esculenta* was studied, with particular attention to root morphology. Destructive harvests each month involved careful excavation of the roots and recording of root length and depth. Roots were observed to remain very shallow (less than 10 cm) while extending out from the plant for over two metres, but ultimately growing down to about 30 cm depth. Feeder roots were not concentrated in or under the mound, except for those growing from

developing tubers. These results call to question the efficacy of fertiliser placement in the mound, and the adequacy of one metre guard rows between fertiliser treatments.

In Tonga, the project established five sites comparing *D. alata* response to N and P rates on soils planted four to five months with *Mucuna cochinchinensis* (velvet bean) and *Panicum maximum* fallow. The results did not show any significant responses as last year. The project staff in Tonga reported that severe drought during tuberisation was the likely cause of no significant responses. *Mucuna* roots were examined microscopically and found to be heavily populated with vesicular-arbuscular mycorrhizae (VAM). In the greenhouse, yams were successfully grown in pot experiments demonstrating P responses on two soils, both taken from sites continuously cropped for five years prior to sampling.

At the University of Queensland, solution culture experiments were completed for deficiencies of nitrogen, boron, iron, copper and molybdenum. In addition, toxicities of boron, zinc and copper were developed to greater intensity than achieved in the trial last year. The copper deficiency experiment successfully used Amberlite IRC-718 cation-chelating resin to induce a range of deficiency levels, with well-developed symptoms. Borate-binding anion-exchange resin Amberlite IRA-743 was trialled for the second time, again with poor results suggesting phytotoxicity to yam. More than 1000 leaf samples were generated by the solution culture experiments, and some 350 samples received from overseas programs. These have been processed in the laboratory, but analysis results are not yet collated for reporting. Due to the sale of the University's research farm at Redland Bay, the root crops germplasm collection was moved to the DPI Redlands Research Farm at Cleveland. All but one of the yam genotypes received from IITA have been destroyed on account of virus infestation. From the remaining four *D. alata* genotypes, leaves were sampled monthly to track changes in leaf nutrient concentrations in leaves at various positions on the vine.

## **Project SMCN/2001/038: Management of animal waste to improve the productivity of Pacific farming systems**

<b>Overseas Collaborating Countries</b>	Fiji, Kiribati, Tonga, Tuvalu
<b>Commissioned Organisation</b>	University of Western Sydney, School of Environment and Agriculture, Australia
<b>Project Leader</b>	Dr Gavin Ramsay Phone: 02 4570 1282 Fax: 02 4570 1750 Email: g.ramsay@uws.edu.au
<b>Collaborating Institutions</b>	Secretariat of the Pacific Community, Division of Animal Health and Production, Fiji University of the South Pacific, School of Social and Economic Development, Fiji
<b>Project Budget</b>	\$381,340
<b>Project Duration</b>	01/07/2002 to 31/12/2005 (Project extended from 01/07/2005 to 31/12/2005)
<b>ACIAR Research Program Manager</b>	Dr Christian Roth

### **Project background and objectives**

Livestock play an important role in the cultures of Pacific island countries. Most animals used to be free ranging. However, livestock numbers have increased to the point where public pressure has forced many owners to tether them or keep them in pens. As a result, waste is concentrated in and around specific areas. Most waste is not collected or managed; rather, it is left where it lays. This contaminates surface and underground water, leading to human health risks and the loss of potential agricultural and economic gains.

Animal manure can be used to produce methane and fertiliser for village crops and gardens. However, time and effort are often required to maintain the equipment needed to do this, and many communities have been unwilling to adopt new practices they do not understand. There is a need for better information on how animal manure can be used more productively in Pacific island countries and on the relevant attitudes and values of local people. The project is helping Pacific island countries to address the issue by developing approaches to better using animal waste productively, rather than allowing it to pollute water supplies to the detriment of human health.

### **Project progress**

#### **Year 3 (01/07/2004 to 30/06/2005)**

The project has continued the consultation with communities and in partnership with the communities has moved to an implementation phase in which new piggeries with alternative waste management systems are being trialled. New piggeries were constructed in Fiji and Tonga and an existing piggery was renovated for demonstration purposes in Tuvalu.

One new piggery was constructed in Votua Village on the Coral Coast of Vitu Levu, Fiji. The area has an increasing population due to the growth of the tourism industry. This had led to an increased number of pigs and therefore higher risk of water contamination. The new piggery is built away from water sources and is a simple construction that could be copied elsewhere.

Further work has been carried out at one village in Fiji with an emphasis on the catchment above the village. Several sources of faecal pollution have been identified and are being investigated. It has been found that while the village had reticulated water the small dam and reservoir were insufficient to meet the needs of the community. As a result contaminated water from the creek adjacent to the village was still the main source of water to the community. Water monitoring has been carried out monthly for over three years and good quality data is available to show the environmental and health risks of contaminated water.

Two new piggeries have been constructed in Ahua, Tonga and will be used as demonstration sites. This project aligns with and will provide information to the AUSAID project on total solid waste management in Tonga. The Tongan Agriculture Department, one of the project partners, is working with the Ministry of Forestry in Tonga and Tonga Trust who are working on solid waste management.

The project generated support and interest from International Waters Project which is operating a similar project in several Pacific Island countries. An agreement was developed to share information between the projects and provide support where relevant.

A major study has been conducted on the importance of pigs in Pacific culture. This study brought together information on the historical links between pigs and people and provides insights into the attitudes of people towards pigs and the customs of raising pigs and using them for ceremonies.

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

<b>Overseas Collaborating Countries</b>	Fiji, Papua New Guinea
<b>Commissioned Organisation</b>	Secretariat of the Pacific Community, Fiji
<b>Project Leader</b>	Mr Sada Lal Phone: 679 3379225 or 679 3370733 ext. 225 Fax: 679 3386326/337 0021 Email: SadaNL@spc.int
<b>Collaborating Institutions</b>	CSIRO Entomology, Australia Ministry of Agriculture, Sugar and Land Resettlement, Fiji National Agricultural Research Institute, Papua New Guinea
<b>Project Budget</b>	\$711,309
<b>Project Duration</b>	01/01/2002 to 31/12/2005
<b>ACIAR Research Program Manager</b>	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 3 (01/01/2004-31/12/2004)**

The SPC Pest Management in the Pacific (PMP) programme (PMP) is one of the two major projects of SPC-Plant Protection Service. PMP 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). Activities in this project have links to both SPC initiatives.

**Papua New Guinea:**

*Metarhizium Anisopliae Ma Field Trial 2 (Keravat)* – this was a repeat of trial one (reported in 2003) using the same design. Three dosages of *Ma* were tested against the standard rate of Chlorpyrifos and an untreated control. *Ma* and Chlorpyrifos failed to give any significant control of the beetle. This further indicates *Ma*'s limitations as a single application.

*Ma/Breeding Sites (and Continuous Application in Successive Taro Cultivations):*

*Ma* in single application is not effective, therefore, placing it in an artificial breeding site in taro plantations may reduce the beetle population over a period of time.

Two strains of *Ma* FI-1452 (the standard) and FI-1472 (collected from the Highlands) were tested to check on the rate of decline of *Ma* conidia in the top soil at Keravat over a one year period. So far FI-1472 seems to deteriorate faster. Two strains of *Ma* (FI-1452 Standard TB 101) and FI-1472 (Highland strain) were tested on two beetle species *P. Woodlarkiana* and *P. huebneri*. The results showed that both *Ma* strains killed both sexes of both species of Taro Beetle. FI- 1452 was better on *P. huebneri* at a lower rate but not on *P. woodlarkiana*.

*On Farm Adaptive Work:* Three target groups have been identified for On Farm Work to determine this. They are: Back Yard Gardens, Smallholder Farms and Institutions.

*Ma Mass production:* The developed protocol has been followed with successful *Ma* cultures now produced without difficulty. Some success has been achieved with chemical sterilisation and the technique should soon be mastered. Both strains of *Ma* are maintained in culture at Keravat and Bubia and re-cultured on a monthly basis to retain their virulence

*Baculovirus Oryctes:* This experiment to determine the pathogenicity of the virus was conducted but DNA in the beetle specimens could not be detected due to an improper preservation method. A simplified form of the original experiment will be conducted early next year to first establish that virus transmission and lethal infection of Taro beetles is possible.

*Insecticides:* Bifenthrin Insecticide is being trialled to test dosage rates. The trial will be finally harvested in March 2005. *Ma*, Confidor and Bifenthrin continue to be progressively trialled, through planting and harvesting at one, three, five and seven months.

#### **Fiji:**

*Comparison of two rates of Ma with chemical Suscon Indigo:* The trial was harvested in March. Beetle infestation was low making detection of the effect of the treatments difficult. There was no significant difference in reduction of the beetle population by either of the treatments. An evaluation of possible synergistic interactions between different dosage of Confidor insecticide and *Ma* had similar problems with low beetle infestation.

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

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

### **Project background and objectives**

Sea cucumbers, processed into *bêche-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 the 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 progress**

#### **Year 5 (01/04/2004-31/03/2005)**

Juvenile sandfish (*Holothuria scabra*) were produced at the hatchery at Saint-Vincent for the third consecutive spawning season. Almost 20,000 juveniles were cultured and grown to sizes greater than 1 g in the first quarter of 2005. Several experiments were conducted in earthen ponds to develop methods for scaling up production of large-sized juveniles. Of note, we have identified ways to significantly improve growth of juveniles in 'hapa' enclosures. Fake sea grass units provide more surface area on which juveniles feed. Shading hapas was not beneficial. A non-linear relationship between initial juvenile size and their survival in hapas was found – this will benefit future aquaculture of sandfish by showing the best size at which to transfer juveniles from the hatchery into hapas in ponds. Experiments on different feeds and sediment addition in 'bag net' enclosures showed that feed is only needed when ponds have low natural productivity, and shrimp starter feed is best for the growth of sandfish from one gram onwards.

Nine thousand sandfish juveniles were grown to one to ten grams and released in the large-scale experiment. Four sites were selected and three open sea pens of 500 m<sup>2</sup> were set up at each site. The juveniles were tagged with one of two fluorochromes, then released into the pens at densities of 0.5, 1, or 3 per square metre. Censuses after two months indicate complete mortality at one site and high mortality at the other three sites, although it is possible that the low water temperatures at that time made the recaptures more difficult because animals burrowed deeper than normal, making them difficult to find. Further censuses will be carried out, as planned, to assess the survival rates over a

longer period. The large-scale trial release of 4,000 sandfish juveniles, which started in July 2004, has shown much higher survival. At one site, survival has been very high and the sandfish have already reached the size of first maturity, one year after release. The monitoring of that trial has been ongoing for one year and will continue for another six months.

The long-term tagging experiment, initiated in January 2004 was completed in January 2005. The results are a breakthrough in the development of reliable, inexpensive markers for juvenile sandfish. Two fluorochromes, calcein and tetracycline, showed complete retention in juveniles over the 12 month duration. Detecting the mark is a short, straightforward process that will be easy for fishery workers in the Pacific. The first manuscript to disseminate the findings is in internal review. Additional experiments were conducted and show the optimal protocols for administering these chemical tags.

The stock assessment surveys of sandfish were completed in the Northern and Southern Province, and stock assessments of other species were completed in the Loyalty Islands Province. Surveys of 35 sites on La Grande Terre, through 314 manta-tow transects, revealed only seven sites had good sandfish stocks. WorldFish has since helped the Northern Province to develop management regulations for their sea cucumber fishery. In the Loyalty Islands Province, were surveyed 34 sites through 305 transects. Significant stocks of black teatfish (*Holothuria whitmaei*), exist at 10 sites, and were at higher density in Lifou and Maré than Ouvéa.

Requests for information on sea cucumber culture and restocking have been steadily increasing. Project-related research presentations were given at the Aquaculture Australasia 2004 conference (Sydney) and the 7th Asian Fisheries Forum (Penang). Articles on growing sandfish in earthen ponds, disease and health protocol, in collaboration with a Belgian colleague, and several summarising the project were published, including in the SPC Fisheries Newsletter and the SPC Beche-de-mer Information Bulletin.

## **Project FIS/2003/051: Improving sustainability and profitability of village sea cucumber fisheries in Solomon Islands**

<b>Overseas Collaborating Countries</b>	Solomon Islands
<b>Commissioned Organisation</b>	WorldFish Center, New Caledonia
<b>Project Leader</b>	Dr Warwick Nash Phone: 687 262000 Fax: 687 263818 Email: w.nash@cgiar.org
<b>Collaborating Institutions</b>	Department of Fisheries and Marine Resources, Solomon Islands WorldFish Center, Solomon Islands
<b>Project Budget</b>	\$399,999
<b>Project Duration</b>	01/01/2005 to 31/12/2008
<b>ACIAR Research Program Manager</b>	Mr Barney Smith

### **Project background and objectives**

Marine resources are important industries in the Solomon Islands. Tuna and sea cucumber (bêche-de-mer) fisheries contribute the most value to the Solomon's economy; both worth millions of dollars annually. Sea cucumbers have been a valuable export commodity, with the export price rising in recent years, at a time when other commodity prices are falling. Another important aspect of utilising marine resources is food and income for smallholders in coastal communities. Sea cucumber harvesting, usually conducted at the village level, creates significant income flows that stream throughout villages and nearby communities. Recent civil unrest has limited the opportunities available to villagers to earn income. One consequence of this has been increased harvesting of sea cucumber.

Increased harvests in the early 1990s, a time of economic hardship, led to a sharp rise in catches that soon proved unsustainable. Soon after harvests declined dramatically. Numbers of sea cucumber have gradually risen but with economic hardship again prevalent following civil unrest many coastal communities are again increasing harvests, threatening a collapse of fisheries. This would be the worst possible result given that income streams would dry up. Sustainable management is needed to ensure that coastal communities can continue to utilise this vital resources without compromising its long-term value. The project is aiming to facilitate this through sound, community-based management of the sea cucumber fishery, working in collaboration with the national Department of Fisheries and Marine Resources and the Provincial governments, and to ensure incomes are available to fishers for the bêche-de-mer that they produce. These objectives will be achieved by:

- working with selected communities to develop sustainable, community-based sea cucumber fisheries and produce high-quality bêche-de-mer;
- assisting communities to obtain improved returns for their bêche-de-mer product.

### **Project progress**

**Year 1 (01/01/2005 to 31/12/2005)**

The first progress report is due in 2006.

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

<b>Overseas Collaborating Countries</b>	Fiji, Kiribati, Malaysia, Papua New Guinea, Samoa, Solomon Islands, Tuvalu, Vanuatu
<b>Commissioned Organisation</b>	International Plant Genetic Resources Institute, Malaysia
<b>Project Leader</b>	Dr V. Ramanatha Rao Phone: +60 3 89423891 Fax: +60 3 89487655 Email: v.rao@cgiar.org
<b>Collaborating Institutions</b>	Secretariat of the Pacific Community, Fiji
<b>Project Budget</b>	\$933,797
<b>Project Duration</b>	01/01/2002 to 31/12/2006 (Project extended from 01/01/2005 to 31/12/2006)
<b>ACIAR Research Program Manager</b>	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 of Primary Industries 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 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 3 (01/01/2004-31/12/2004)**

*Develop a framework for the establishment of effective sui generis protection of PGR:* An information paper on policies related to PGR for Food and Agriculture, which was reviewed and revised by SPC. The paper was presented at the PAPGREN meeting in May 2003, where it was well received by PICTs. It was thereafter published as an SPC pamphlet, entitled *Policy Issues Related to PGR in the Pacific: A Guide for Researchers and Policymakers*. The English and French versions have been widely distributed in the PICTs to create greater awareness of PGR policy issues. An information paper on the ITPGRFA was also prepared for the September 2004 meetings of Pacific Ministers and Heads of Agriculture and Forestry (HOAFS) <http://spc.int/AC/artAgricultureForestryMeeting.htm> .

*Hold national PGR stakeholder workshops to identify PGR priorities:* Informal consultations were held in 2004 in Solomon Islands, Vanuatu, RMI, Pohnpei, Palau and Kiribati, mainly in conjunction with other meetings and visits. With complementary support from FAO Global Plan of Action (GPA) implementation monitoring exercises were carried out in Fiji and PNG, with the PGR focal points in these countries and resulted in comprehensive reports on the current PGR situation in the two countries and progress in the 20 priority areas of the GPA.

*Document existing germplasm collections and publish national and regional PGR inventories:* A *Directory of Plant Genetic Resources Collections in the Pacific Island Countries and Territories* (<http://www.spc.int/pgr/Documents/Databases/Databases.htm>) was published in late 2004 in consultation with national partners and other experts and widely distributed in the region and beyond. The directory also included information on Pacific germplasm held outside the region. This information was forwarded to IPGRI and FAO for updating the information in their databases. The *Directory* is the first fully comprehensive region-wide review of germplasm holdings in the Pacific, and a significant awareness as much as technical product.

*Develop awareness of PGR and of the network:* Four PAPGREN meetings co-funded by NZAID have been held from May 2002 to the present. These have been expensive undertakings, but have proved essential for building up trust and maintaining a collegial atmosphere within the network and stimulating the exchange of information and ideas.

*Train trainers in priority thematic areas on regional basis:* PAPGREN organised a course on PGR documentation in August 2004 at SPC, Suva, Fiji. There were 12 participants from 7 Pacific Island Countries. All participants took home a folder containing a large number of resources, including handouts of the main presentations, descriptor lists and other materials relevant to PGR documentation which was also provided on CD-ROM. The latest PAPGREN meeting concentrated on education and training. PGR practitioners from PNG, RMI, Samoa, Palau, Vanuatu and the Melanesian Farmer First Network detailed their perceived local-level, national and regional needs in the area of PGR education/training/capacity building and this was matched with the expertise available in the region and beyond.

*Support priority conservation activities by National Programmes:* Once the basic structure of the network is in place, national and regional priorities for specific conservation actions on priority crops (<http://www.spc.int/pgr/> and click on "Crops") can be discussed, agreed and implemented.

## **Project SFS/2003/047: Improved plant protection in the Solomon Islands**

<b>Overseas Collaborating Countries</b>	Solomon Islands
<b>Commissioned Organisation</b>	Secretariat of the Pacific Community, Fiji
<b>Project Leader</b>	Mr Stephen Hazelman Phone: 679 3370733 Ext 258 Fax: 679 3370021 Email: Stephenh@spc.int
<b>Project Web Site</b>	<a href="http://www.pestnet.org/">http://www.pestnet.org/</a> ; <a href="http://www.terracircle.org.au/team/rk.html">http://www.terracircle.org.au/team/rk.html</a> ; <a href="http://www.terracircle.org.au/projects/kga/kga.html">http://www.terracircle.org.au/projects/kga/kga.html</a>
<b>Collaborating Institutions</b>	Department of Agriculture and Livestock, Solomon Islands Kastom Gaden Association, Solomon Islands Vois Blong Mere Solomon, Solomon Islands
<b>Project Budget</b>	\$398,260
<b>Project Duration</b>	01/01/2005 to 31/12/2007
<b>ACIAR Research Program Manager</b>	Dr Simon Hearn

### **Project background and objectives**

Food security in many areas of the Solomon Islands is built on subsistence agriculture. Root crops are the staple foods, along with fruit and nut species and leaf and other vegetables. Agricultural production involves more than 80 per cent of the population, with women the main food producers. Surpluses of food, when produced, are usually sold to meet household expenses. One of the major problems faced by most smallholder farmers is pests. Another is diseases attacking crops. For pests the main controls are pesticides, but these are expensive. Buying pesticides means foregoing income that could be spent elsewhere, especially on household needs. Pest and disease problems are particularly prevalent in rural areas with high population densities.

Exacerbating these problems is the breakdown and loss of infrastructure reflecting the broader declines in infrastructure during the civil unrest and tensions of recent years. The main Department of Agriculture and Livestock research complex was destroyed by fire in 2000 and the remaining facilities lack resources. With both the farming and research community lacking resources to address pest and disease management the project is rebuilding these areas by:

- developing integrated pest management (IPM) strategies for major food crops, and
- increasing government staff and community awareness and understanding of plant pests and diseases, leading to improved and sustainable crop management.

### **Project progress**

#### **Year 1 (01/01/2005 to 31/12/2005)**

The first progress report is due in 2006.

# Concluded projects

at 30 June 2005

## Multilateral

FST/2001/045	Development of forest health surveillance systems for South Pacific countries and Australia	66
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## Project FST/2001/045: Development of forest health surveillance systems for South Pacific countries and Australia

<b>Overseas Collaborating Countries</b>	Fiji, Samoa, Tonga, Vanuatu
<b>Commissioned Organisation</b>	Dept Primary Industries and Fisheries, Queensland Government, Australia
<b>Project Leader</b>	Dr Ross Wylie Phone: 07 3896 9781, mobile: 0408459344 Fax: 07 3896 9628 Email: Ross.Wylie@dpi.qld.gov.au <a href="http://www.dpi.qld.gov.au/home/default.html">http://www.dpi.qld.gov.au/home/default.html</a>
<b>Project Web Site</b>	<a href="http://www.dpi.qld.gov.au/home/default.html">http://www.dpi.qld.gov.au/home/default.html</a>
<b>Collaborating Institutions</b>	Ministry of Agriculture, Sugar and Land Resettlement, Fiji Ministry of Agriculture and Forestry, Tonga Secretariat of the Pacific Community, Fiji Forestry Tasmania, Australia Department of Forests, Vanuatu Ministry of Agriculture, Forests, Fisheries and Meteorology, Samoa CSIRO Entomology, Australia Fiji Pine Ltd, Fiji Melcoffee Sawmills, Vanuatu Vanuatu Department of Agriculture, Horticulture and Quarantine Inspection Service, Vanuatu
<b>Project Budget</b>	\$399,509
<b>Project Duration</b>	01/07/2002 to 31/12/2004
<b>ACIAR Research Program Manager</b>	Dr Russell Haines

### Project background and objectives

Forests have high value to the people of the South Pacific. They provide food, timber, building materials, identity, employment and exports. Pests and diseases are a major cause of reduced forest productivity in both natural forests and plantations. Regular surveys of forest areas by trained local forestry staff can detect damaging pests and diseases early and therefore protect investment in forests.

Previous ACIAR studies have raised concerns about the potential threat to forests in the region as new pests are seen. Early detection will limit the impact of pests and diseases, but skills and resources are required. Without an adequate forest health surveillance program, South Pacific countries risk serious losses in production and lose the ability to access premium international markets. The aim of this project was to help local workers in Fiji, Vanuatu, Tonga and Samoa to detect damaging pests and diseases in forests. It was designed to teach local communities to better manage their own forests, to improve productivity and economic gain and to reduce pressure on native forests.

### Project outcomes

Training sessions on forest health were organised in three countries by local project participants for forestry staff in the regions and for community groups. In Vanuatu, 30 staff from the Department of Forestry spanning five provinces and six staff from the Vanuatu Quarantine and Inspection Service attended a two-day FHS training workshop held in October 2003. Personnel trained at this workshop can now conduct forest health surveys in nurseries, woodlots, agroforestry plots and around ports. In Fiji, project staff provided training to personnel from Fiji Pine and Fiji Hardwoods Corporation on methods of forest health surveillance, and in Samoa villagers involved in community forestry projects received similar training.

In March-April 2004 project personnel from Queensland and Tasmania undertook forest health surveys in eucalypt plantations in Tasmania (around Launceston and Huon Valley), to determine the efficacy of detecting symptoms of pest and disease damage during routine forest health surveillance. Methodologies tested were aerial survey, roadside vehicle cruise, and ground surveys.

The final project workshop was held in Brisbane in October 2004. Its purpose was to reinforce training already provided, to allow Pacific participants to view first-hand some of the forest pest problems and surveillance methodologies used in Australia, and to collate and discuss data collected during the project. The major forest health needs identified in the Pacific were: increased training, increased quarantine awareness, and pest and disease identification.

One major impact arising from the project is the change engendered in the attitudes towards forest health issues within participating countries and across the region. Until now the focus in the Pacific has been primarily on pests of agriculture and horticulture but there is a new awareness of forest health and forest biosecurity across a range of stakeholder groups concerned with agriculture, forestry and quarantine in Fiji, Vanuatu, Samoa and Tonga, and with the forestry industry. There has been an increased level of understanding and cooperation between these groups on forest health matters and promise of future collaboration.

The project led to the establishment in the four countries of small, sustainable forest health units, which are conducting ongoing forest and port environment surveys and providing training to forestry staff and community groups. These units now have access to a network of forest health specialists in the region.

The scientific impact of the project has also been significant. The surveys conducted in 2004 by project staff in eucalypt plantations in Tasmania provided valuable information for forest managers and scientists on the efficacy of various methods of pest and disease detection currently in use in forest services around Australia and allowed calculation and assessment of cost/benefit. They became aware of how difficult it is to detect symptoms of damage by organisms such as stem borers and fungal canker at low incidence in plantation trees by any of the methods currently available. The implication for biosecurity is that an incursion of this type of pest in a forest situation is unlikely to be detected sufficiently early to allow eradication, and therefore surveillance should focus on high-risk areas around ports and container facilities.

Another finding is that overview surveillance (e.g. aerial, vantage point) combined with roadside surveys is the most cost-effective methodology for detection of gross symptoms of tree disorder such as dead or dying trees and defoliation. This is the first such large-scale testing of forest surveillance techniques in Australia. It will engender changes in routine plantation surveillance in Australia and facilitate refinement of survey methodology for smaller woodlot plantings here and in the Pacific. The project has a web page linked to the SPC site. It contains information about the project, ACIAR, forest pests and diseases in the Pacific, and project publications including survey reports, Country Plans and instruction manuals.

# Projects under development

at 30 June 2005

## Bilateral

SFS/2004/030	Control of Asian bees - Solomon Islands
CP/2004/063	Integrated pest management in a sustainable production system for Brassica crops in Fiji and Samoa
FST/2004/054	Improving value and marketability of coconut wood
FIS/2003/070	Marketing options and opportunities for seaweed in the Pacific
FST/2004/053	Establishing forest pest detection systems in South Pacific countries and Australia
FST/2005/089	Improved silvicultural management of <i>Endospermum medullosum</i> (whitewood) for enhanced community forestry outcomes in Vanuatu
CP/2004/049	Improved farming systems for managing soil-borne pathogens of ginger in Fiji and Australia
CP/2004/064	Biological control of "mile-a-minute" ( <i>Mikania micrantha</i> ) in Papua New Guinea and Fiji

## Multilateral

FIS/2003/059	Testing the large-scale restocking of sandfish ( <i>Holothuria scabra</i> )
PHT/2005/077	Integrated crop management package for sustainable home gardens in the Solomon Islands

# South Pacific consultations

9–10 December 2003

Priorities for collaborative agricultural research between ACIAR and its Pacific Island country partners (Fiji, Samoa, Solomon Islands, Tonga, Vanuatu and Kiribati) were discussed on 9–10 December 2003 in Suva at a consultation with representatives of Regional Organisations (including SPC and University of the South Pacific), relevant Government Ministries and Agencies, NGOs and CGIAR centres active in the region.

ACIAR's strategy in these Pacific island countries addresses the significant challenges of WTO accession, quarantine- and biosecurity-related issues, product quality, scale of production, and remoteness of export markets. We will maintain a mixture of research on cash-generating crops, fishing and forestry with emphases on supply chain issues (including value-adding and marketing) and production sustainability. Projects will emphasise technologies that are appropriate to smallholders, and address institutional issues affecting technology uptake. The limited research capability in the region, especially in individual nations, is an ongoing constraint. ACIAR will therefore work closely with regional organisations, especially the Secretariat of the Pacific Community (SPC), in executing projects. ACIAR also supports collaboration by Pacific Island countries with International Agricultural Research Centres such as the WorldFish Center and the International Plant Genetic Resources Institute.

Agreed priorities are listed under selected ACIAR program areas.

## **Crop Sciences**

- Identification of quarantine and pest risk issues for specific crop germplasm requiring exchange between countries for conservation and introduction purposes
- Development of integrated crop management packages (specifically for pest, weed and disease control and other quarantine issues) for breadfruit, yam and sweet potato
- Integration of existing knowledge into information packages for bananas and taro
- Facilitation of national adoption of earlier research on pest, weed and disease management (including biocontrol)
- In Tonga, research on environmentally-appropriate pest and disease management is required to maintain the export squash industry

## **Fisheries and livestock**

- Stock status assessment and management planning for the sustained use of vulnerable inshore fisheries resources, with an emphasis on increased community-level management and co-management approaches
- Economic and marketing analyses of key aquaculture commodities (initial focus to be seaweed) to better inform producer decision making and to identify opportunities for regional cooperation in marketing and processing
- Regional studies of import risks associated with the movement of live aquatic organisms and the definition of appropriate quarantine measures and strategies
- Investigation of new opportunities for inland aquaculture, including the domestication of promising indigenous species and integration of aquaculture into existing farming systems
- Utilisation of locally-available materials (including waste products) to develop cost-effective feed formulations which improve nutrition in pigs, poultry and aquaculture species

## **Forestry**

- Watershed protection functions and groundwater management in forestry systems
- Domestication of multipurpose trees, including selection of suitable germplasm and silvicultural management
- Sustainable management (and protection from pests and diseases) of high value plantations, including silviculture, harvesting and re-establishment practices

- Value-adding in processing of forest products, including coconut wood and lesser-known species, mahogany branch and salvage wood, and use of mobile sawmills for processing
- Control of exotic, invasive plant species in plantation and agroforestry, especially vine and tree species

#### **Agricultural Economics**

- Land and water resource use planning for optimal development of agriculture, forestry and fisheries enterprises
- Improved agricultural statistics to develop indicators that measure smallholder/ subsistence farmer contributions to national economies. Quantification of the number of farmers producing, levels of household consumption and supply chain linkages.
- Marketing research for root crops, taro and cassava to underpin development of a structured supply chain, with emphasis on quality standards, consistency of supply and packaging requirements
- Economic analysis of current and new farming practices, including of alternatives to slash and burn agriculture and organic farming
- Economic analysis of returns and certification issues of current and potential crops or commodities
- Resource valuations and economic analyses of subsistence and commercial fisheries
- Analysis of the economic tradeoffs incurred in moving from access fee arrangements for Distant Water Fishing Nation vessels to domestic allocation of tuna harvests and onshore processing/transshipment requirements

# ACIAR publications

This list is a selection of titles from ACIAR's range of scientific publications that are relevant to the agricultural research and development sector of the Pacific island countries. Hard copies are available by emailing [comms@aciar.gov.au](mailto:comms@aciar.gov.au). Publications may also be downloaded from ACIAR's website, [www.aciar.gov.au](http://www.aciar.gov.au).

## Monographs

- 06 Chemistry of tropical root crops: significance for nutrition and agriculture in the Pacific
- 09 Giant clams in Asia and the Pacific
- 12 Biological control – Pacific prospects: Supplement 1
- 14 The giant clam: an anatomical and histological atlas
- 15 The giant clam: a hatchery manual
- 16 The giant clam: an ocean culture manual
- 18 Giant clams in the sustainable development of the South Pacific
- 20 Biological control – Pacific prospects: Supplement 2
- 27 Recollections of a Pacific entomologist
- 28 The economics of Papua New Guinea tuna fisheries
- 29 Stock assessment of coconut crabs
- 33 Illustrated guide to the identification of banana varieties in the South Pacific
- 35 A survey of the subsistence and artisanal fisheries in rural areas of Viti Levu, Fiji
- 38 Protected area assessment in Vanuatu: a socioeconomic approach
- 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
- 54 Survey Toolbox for Livestock Diseases: practical techniques for developing countries
- 55 A bibliography of food and other crops in Fiji
- 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 tree crop industries in Papua New Guinea
- 85 Fruits of Oceania
- 94 Survey Toolbox for Aquatic Animal Diseases: A Practical Manual and Software Package
- 100 Field methods for rodent studies in Asia and the Indo Pacific
- 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
- 110 Advances in grouper aquaculture
- 119 Guidelines for surveillance for plant pests in Asia and the Pacific

## Proceedings

- 20 Management of wild and cultured sea bass/barramundi (*Lares calcarifer*)
- 21 Banana and plantation breeding strategies
- 24 Smallholder agricultural development in Tonga
- 28 Tropical tree seed research
- 30 Tuna baitfish in the Indo-Pacific region
- 47 The biology and mariculture of giant clams
- 52 Tuna baitfish in Fiji and the Solomon Islands
- 53 Coconut improvement in the South Pacific
- 66 Bluetongue diseases in the Asia-Pacific region
- 69 South Pacific indigenous nuts
- 76 Fruit flies in the Pacific
- 78 Mud crabs
- 79 Trochus: status, hatchery practice and nutrition
- 99 Food security for Papua New Guinea

- 102 Biological and integrated control of water hyacinth
- 119 Agriproduct supply-chain management in developing countries

### **Technical Reports**

- 02 Pastures in Vanuatu
- 04 Coconut germplasm in the South Pacific Islands
- 05 South Pacific agriculture — challenges & opportunities for ACIAR & its research partners
- 11 Economic prospects for vanilla in the South Pacific
- 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
- 19 Utilisation of remote sensing in the South Pacific
- 23 Allozyme electrophoretic methods for analysing genetic variation in giant clams
- 24 Tuna baitfish and the pole-and-line industry in Kiribati
- 36 A guide to the zygotic embryo culture of coconut palms
- 44 A variety collection of edible nut trees in Solomon Islands
- 46 Kava (*Piper methysticum*) in the South Pacific
- 55 Chromolaena in the Asia–Pacific region
- 58 Evaluation of international provenance trials of *Casuarina equisetifolia*