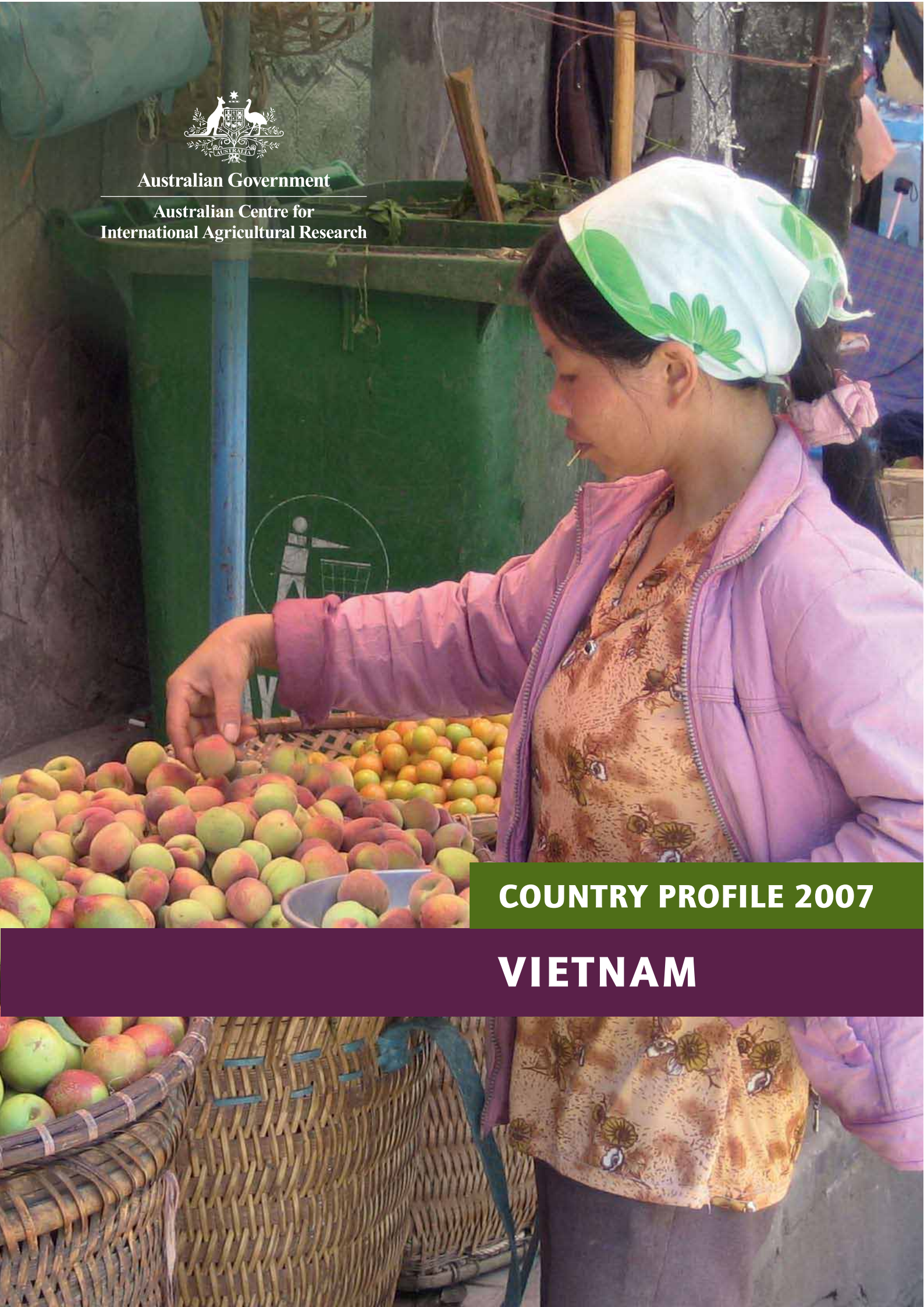




Australian Government
Australian Centre for
International Agricultural Research



COUNTRY PROFILE 2007

VIETNAM



Australian Government

**Australian Centre for
International Agricultural Research**

COUNTRY PROFILE 2007

VIETNAM

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.

© 2007 Australian Centre for International Agricultural Research
GPO Box 1571 Canberra ACT Australia 2601

ACIAR. *Country Profile: Vietnam*. 2007.

ISBN 978 1 86320 565 8 (print)
ISBN 978 1 86320 566 5 (online)

Additional copies of this publication are available from ACIAR offices:

In Vietnam:

Mr Geoff Morris
Manager Vietnam
Tel: +84 4 831 7755 ext 202
Fax +84 4 831 7707
Email: geoff.morris@dfat.gov.au
Postal address:
Australia Embassy
8 Dao Tan Street
Ba Dinh District
Hanoi
Vietnam

In Australia:

Ms Liz Clarke
Manager Communications and Secretariat Unit
Tel: +612 6217 0500
Fax: +612 6217 0501
Email: comms@aciar.gov.au
Postal address:
GPO Box 1571
Canberra ACT 2601

Website: www.aciar.gov.au

Printed by Union Offset Printers

Contents

1	Preface	1
2	Overview	2
2.1	ACIAR	2
2.2	Country Portfolio	3
3	ACIAR Contacts	4
3.1	Country Office	4
3.2	R&D Program	4
3.3	Policy Advisory Council member	5
4	Training	6
5	Annual Report 2006-07	7
5.1	Medium-term strategy	7
5.2	Position.....	8
5.3	Relationship to the AusAID Vietnam strategy	8
5.4	Achievements.....	9
5.5	Facing the future for Vietnam’s reservoir aquaculture	11
6	Annual Operational Plan 2007–08	13
6.1	Key performance indicators (2007–08).....	13
6.2	Medium-term strategy	13
6.3	Position.....	13
6.4	Relationship to the AusAID Vietnam strategy	14
6.5	Indicative priorities	15
7	Projects (summary and progress reports)	16
7.1	Subprogram 1: Increasing market competitiveness of Vietnamese agricultural and fisheries products	16
7.2	Subprogram 2: Optimising water and soil management for sustainable production, particularly on degraded lands.....	80
8	ACIAR Publications	96

1 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 Vietnam that were active from 1 July 2006 to 30 June 2007. At that time there were 37 active bilateral projects, and two active multilateral projects, the latter being led by international agricultural research centres. There were another 12 projects under development, many of which are expected to start in 2007–08 financial year.

This publication also sets out the key outputs and outcomes from five bilateral projects that have been completed between 1 July 2006 and 30 June 2007.

In addition to these project summaries, the publication includes an extract from ACIAR's 2006–07 Annual Report covering Vietnam, our near-term program as outlined in the 2007–08 Annual Operational Plan, and a summary of ACIAR's training program.

ACIAR updates this profile each year and distributes it to key stakeholders in Vietnam and Australia.

We hope you find the publication useful as a record of the progress and achievements between Vietnam and Australia. For information on ACIAR's overall program, we invite you to visit our website at www.aciar.gov.au.



Peter Core
Chief Executive Officer
November 2007



Geoff Morris
ACIAR Country Manager, Vietnam

2 Overview

2.1 ACIAR

The Australian Centre for International Agricultural Research (ACIAR) is an Australian Government Statutory Authority that operates within the portfolio of Foreign Affairs and Trade. It was established in June 1982 under the ACIAR Act to assist and encourage Australia's agricultural scientists to use their skills for the benefit of developing countries, and at the same time work to resolve Australia's own agricultural problems.

ACIAR's aims to enhance rural household incomes and broader economic growth by investing in international research partnerships that encourage agricultural development, sustainable use of natural resources and capacity-building of benefit to partner countries and Australia.

Research funded by ACIAR is mutually beneficial to Australian and developing country rural industries by harnessing Australia's outstanding strengths in agricultural research to develop partnerships with developing country research institutions.

ACIAR is based in Canberra, with offices in China, India, Indonesia, Papua New Guinea, the Philippines, Thailand and Vietnam.

Australia is in a particularly strong position to provide such assistance because it has a broad range of climates – cool and warm temperate, subtropical and tropical – that are typical of the developing world. Australia's scientists work within a very strong network of institutions, such as the CSIRO, Federal and state government organisations and universities.

The Australian Centre for International Agricultural Research (ACIAR) carries out research in the Asia-Pacific region, and currently has projects in the following regions:

- South-East Asia (Vietnam, Cambodia, Laos, Thailand, Indonesia, Philippines: >45% bilateral expenditure)
- Papua New Guinea and the Pacific islands (>20% of bilateral expenditure).
- North Asia (China: <15% of bilateral expenditure)
- South Asia (India, Pakistan, Bangladesh, Bhutan, Afghanistan, Iraq: <15% of bilateral expenditure)

ACIAR is also responsible for Australia's relationship with the International Agricultural Research Centres—the Consultative Group on International Agricultural Research (CGIAR) centres. ACIAR's annual outlay to the CGIAR centres is around \$11 million.

These funds are used to facilitate CG engagement in the Asia-Pacific and to commission projects that are consistent with ACIAR's country program strategies.

2.2 Country Portfolio

ACIAR has supported a program of collaborative agricultural research with Vietnam since 1993. Most of the program consists of bilateral projects, in which an Australian research organisation is commissioned to undertake a specified research activity in collaboration with a partner organisation in Vietnam. Vietnam is also targeted in ACIARs multilateral program delivered in conjunction with the international agricultural research centres.

ACIAR's program with Vietnam as at 30 June 2007.

Bilateral Program

Active projects	38 with a value over their lifetime of approximately \$10,914,882
Projects under development	11
Share of South East Asia program	\$2,912,043 which represents 15.0% of the total 2006-2007 South East Asia program.
Completed projects	74

Multilateral Program

Active projects	3 with a value over their lifetime of approximately \$921,311
Projects under development	2
Completed projects	12

3 ACIAR Contacts

3.1 Country Office

Country Manager	Mr Geoff Morris
Email	geoff.morris@dfat.gov.au
Phone	+84 4 831 7755 ext 202
Country Assistant Manager	Ms Nguyen Thi Thanh An
Email:	thi-thanh-an.nguyen@dfat.gov.au
Phone	+84 4 831 7755 ext 263

3.2 R&D Program

Regional Coordinator	Dr John Skerritt
Email	skerritt@aciarc.gov.au
Phone	+61 2 6217 0510
Regional Coordinator Assistant	Stephanie Bennett
Email	bennett@aciarc.gov.au
Phone	+61 2 6217 0559
Ms Liz Clarke	Communications and Secretariat
Email	clarke@aciarc.gov.au
Phone	+61 2 6217 0535

Key Program Managers

Dr TK Lim	Crop Protection
Email	lim@aciarc.gov.au
Phone	+61 2 6217 0508
Mr Barney Smith	Fisheries
Email	smith@aciarc.gov.au
Phone	+61 2 9527 8462
Dr Russell Haines	Forestry
Email	haines@aciarc.gov.au
Phone	+61 2 6217 0549
Dr Gamini Keerthisinghe	Soil Management and Crop Nutrition
Email	keerthisinghe@aciarc.gov.au
Phone	+61 2 6217 0558
TBA	Livestock Production Systems
Email	aciarc@aciarc.gov.au
Phone	+61 2 6217 0541

3.3 Policy Advisory Council member

The ACIAR Policy Advisory Council is established under the Australian Centre for International Agricultural Research Act 1982. Members are appointed by the Minister for Foreign Affairs, and represent ACIAR's key stakeholders or the implementing agencies for ACIAR's program in partner countries and Australia. Council members are drawn from government departments, research providers and industry, and are therefore well placed to advise on their respective countries' development and agricultural priorities and research needs.

The current member from Vietnam is Dr Nguyen Van Bo, President, Vietnamese Academy of Agricultural Sciences. Dr Bo has been a member of the Council since March 2004.

4 Training

The ACIAR training program has a budget in 2007–08 of approximately \$5.57 million. It comprises five elements:

- Fellowships for postgraduate students (John Allwright Fellowships)
- Postgraduate returnee follow-up awards (Returnee Small Project Awards Scheme)
- Leadership development opportunities for developing country scientists (John Dillon Memorial Fellowships)
- Non-award training (short courses and workshops)
- Support for the Crawford Fund, both through management of the Australian Government's contribution (\$0.70 million) and sponsorship of attendees at Master classes and other selected training activities.

Much of ACIAR's training is carried out systematically within individual projects. In addition, specialised, discipline-specific training activities may also occur within ACIAR's individual research and development programs.

The ACIAR John Allwright Fellowship Scheme accounts for approximately \$4.53 million (this figure includes \$3 million from AusAID) of the training program budget in 2007–08. The objective of the Scheme is to increase the research and development capacity of ACIAR partner country institutions. It provides funding for promising overseas researchers associated with ACIAR projects to undertake postgraduate studies in tertiary institutions in Australia.

John Allwright Fellowship Statistics

		PhD	MSc/Other
Active	Male	8	5
	Female	3	2
Concluded	Male	7	2
	Female	1	1

5 Annual Report 2006-07

Active projects in 2006-07	41
AOP budgeted expenditure in 2006-07	\$3,141,101
Actual expenditure in 2006-07	\$2,912,043
Expenditure in 2005-06	\$2,818,648
Expenditure in 2004-05	\$2,983,069

Key performance indicators	Performance 2006-07
Linkages between ACIAR-funded research and AusAID-funded development continues to be maintained in least four CARD projects	Direct linkages between ACIAR projects and seven new AusAID CARD projects selected for commencement in 2006/07.
Surveillance and diagnostic systems and manuals developed for plant pest and diseases	Manual developed on surveillance for plant and used in courses conducted throughout Asia. A second manual covers the collation of disease information, illustrations and training notes used in disease diagnosis from many ACIAR projects.
Adoption of fruit fly management technology and commercialisation of protein baits in north and south Vietnam	Adoption of fruit fly management technology by tropical fruit growers in southern Vietnam has spread to low chill stone fruit growers in northern Vietnam. Joint venture established to commercialise the baits.
Increased emphasis on animal health and biosecurity issues commensurate with the rising concern of Avian Influenza and Vietnam as an Asian epicentre.	Several projects help Vietnamese farmers to manage biosecurity threats, including avian influenza, pest fruit flies, citrus greening, stored grain pests and brown plant hopper and viruses in rice.
Continued emphasis in aquaculture and fisheries with new projects on shrimps and oysters initiated.	A project to assist with the development of a profitable small-holder based marine mollusc culture industry in Vietnam will start in July. Vietnam is also a key partner country in an ACIAR funded NACA mediated regional network which will be established to promote the development and broad application of best management practices in shrimp culture through the timely sharing of experience and information.
40 per cent of new projects designed to have significant farmer or policymaker impacts within five years of completion	Four of six projects developed (two standard projects and four small R&D activities) were deemed to have these potential impacts.

5.1 Medium-term strategy

ACIAR's Vietnam strategy emphasises research to assist the enhancement of smallholder incomes through crop and livestock diversification within farming systems, and improving market access through the improvement of the safety and quality of agricultural products. Research will examine the comparative advantage of particular commodities for domestic and export markets and options for the development of rural agricultural enterprises, including efficiencies of cooperative production and marketing. Fisheries research cooperation will focus on aquaculture,

while forestry cooperation will address both conservation and utilisation, with an increased emphasis on higher value products. Natural resource management research will focus on sustainable cultivation systems for poor soils in central and southern Vietnam and on water conservation. Close linkages to AusAID-funded programs (Collaboration for Agriculture and Rural Development (CARD) and the Quang Ngai Rural Development program) will continue to be strengthened.

5.2 Position

ACIAR's program in Vietnam commenced in 1993, and since that time a significant program in forestry, land and water resources, animal sciences, crop sciences, fisheries and postharvest technology has emerged. While training remains very important there has been an evolution from a predominant emphasis on capacity building to one of practical farmer and policy impact.

Some successes include improvements to rice-shrimp farming, integration of mangrove forestry and shrimp production, improvements to inland pond and small reservoir culture fisheries, introduction and dissemination of improved pig breeds, non-chemical rodent control in rice crops, fast-growing acacias, introduction of improved *Acacia* forest germplasm, better irrigation management, improved soil fertility management and better control of citrus pests. Some of the technologies arising from these projects are being applied and capacity developed in R&D and extension through the AusAID CARD program.

Several new projects focus on extension or adaptation of outputs from earlier ACIAR projects in Vietnam and elsewhere in the region. While most of ACIAR's program is currently based in greater Ho Chi Minh City and Hanoi because of the location of research institutes and policy-makers and the national relevance of much of the portfolio, at the February 2004 country consultation it was agreed that emphasis on central Vietnam, particularly central coastal regions, should increase.

ACIAR will also continue to seek greater involvement of the private sector and NGOs in projects, linkages with other R&D activities and donors, and development of closer linkages between Vietnamese research and extension organisations. There will also be an increased emphasis on implementation of the results of earlier ACIAR-funded research, including developing manuals and other communication materials.

5.3 Relationship to the AusAID Vietnam strategy

AusAID's program in Vietnam has two strategic objectives. Within the first, 'Broad-based growth by strengthening the governance of the institutions required for a competitive market economy', two sub-objectives are emphasised — to improve the private sector operating environment and to facilitate internal and international economic integration. Within the second, 'Improved livelihoods for the rural poor focusing on the Mekong Delta and the Central Coast', there is emphasis on four sub-objectives: increased rural productivity, developing human capital, reducing vulnerability to environmental and economic shocks, and strengthening the capacity and accountability of government and the participation of the poor in their governance.

ACIAR's Vietnam program complements AusAID's strategy closely, by supporting underpinning research and development interventions. Major emphases are collaborative investigation of better policy options and interventions for meeting market specifications and opportunities and technical cooperation to improve market access through the improvement of the safety and quality of agricultural and fisheries products. Although much of the program is necessarily based in Ho Chi Minh City or Hanoi and surrounding provinces because of the location of research institutes and policy-makers and the national relevance of particular projects, there is strong emphasis on central coastal regions and the Mekong Delta, with half of the projects in the portfolio working in these regions.

5.4 Achievements

During 2006–07 new project opportunities were taken up in selected areas of agricultural development policy and economic analysis, animal sciences and fisheries. As well, a number of current projects across all program areas were extended to increase the uptake of results by farmers and also incorporate them in the policy process.

The program was divided into the following themes:

- Increasing market competitiveness of Vietnamese agricultural and fisheries products
- Optimising water and soil management for sustainable production, particularly on degraded lands

ACIAR has contributed a sustained effort to develop better policy interventions for meeting market specifications and opportunities. A project to strengthen agricultural marketing activities in Vietnam has undertaken case studies on fruit marketing in the northern mountainous regions. These studies were later discussed at a workshop attended by Department of Agriculture and Rural Development scientists, district extensions officers, People's Committee officials, and several fruit farmers. The discussion revealed the need to give more emphasis to markets, particularly when developing policies supporting supply expansion. During the project Vietnamese economists had the opportunity to observe and learn from a field trip to Australia. They visited ABARE, the Productivity Commission, and the Economics Division of the New South Wales Department of Primary Industries, as well as several Universities. Another visit of significance was to the Sydney Fish markets. The trip introduced them to some institutional design concepts that are being incorporated into Vietnam's new Institute for Policy and Strategy for Agriculture and Rural Development.

Tay Nguyen (Central Highlands) supplies agricultural and forestry produce to domestic and international markets, and the region is also the leading coffee producer. Government policies have intensified agriculture and forestry and population has also risen in the past three decades. Groundwater consumption has now reached unsustainable levels, with droughts in 2003 reducing agricultural production and threatening domestic water supplies. A project is

undertaking biophysical and socio-economic **assessment of groundwater access**. The project team is calculating long-term water availability, conducting a social cost-benefit analysis, and then guiding the development of a cost-effective institutional framework to encourage improved water use. Data gathered from extensive surveys have enabled researchers to estimate household water demand and environmental flow values. As well, farm survey results have helped to estimate the water crop production function for dry season irrigated rice. The findings reveal substantial scope for increased irrigation efficiency in rice production, which will actually improve economic returns to rice farmers. This increase in efficiency will reduce volumetric demand for water, making more available for other uses.

Diseases of fruits and vegetables affect many crops in Vietnam, including coffee, pepper, watermelon, sugar, citrus and durian. Diseases, especially soilborne fungal diseases, are a concern in the central provinces of Quang Nam, Quang Tri and Hue. Earlier ACIAR-supported research with the Hanoi Agricultural University (HAU) built molecular diagnostic capacity, and now a project is focusing on building capacity in diagnosis of soilborne diseases in these three provinces. To date the research team has established diagnostic laboratories in each province and surveys are under way. So far the team has identified the pathogens causing quick wilt of black pepper, pineapple heart rot and peanut root rot. Fungal diseases identified in Quang Nam include a key disease of short and tall beans and three pathogens of chilli (a major crop). Bacterial wilt was diagnosed in a range of crops such as tomato, bitter melon and tobacco, indicating that this pathogen is of significant economic importance. An initial survey of coffee decline indicates that the problem may be a consequence of termite damage of the bark on the upper tap root and lower stem. This facilitates infection by fungal pathogens which then develop a slowly spreading root rot. Trials are now in progress to evaluate control measures for all the identified pathogens.

Although the small **temperate fruit industry** in the northern Vietnamese uplands is the subject of much research, outcomes will be limited without improved postharvest fruit handling and effective disease controls. Up to 25 per cent of fruit was lost and marketed produce often small and immature. A project has focused on identifying and implementing feasible improvements. The initial strategy has been to conduct experiments in commercial orchards, prove the management techniques under Vietnamese conditions then use the results as extension tools. As a result fruit quality has already improved in experimental orchards across three North Vietnamese peach and plum production regions, largely through simple management techniques costing little to implement. Vietnamese project staff learn the techniques and pass them on to farmers. The addition of fertilisers, mulches, canopy management, fruit thinning and pest management has led to larger, better quality fruit and farmers are now receiving better prices for their produce.

During 2006–07 there was continued emphasis in aquaculture and fisheries. The adjacent box gives details of progress with reservoir aquaculture. Other projects addressed issues of culturing mud crabs, spiny lobster, shrimp, finfish and molluscs. Results from **feeding experiments with mud crabs** in intensive culture systems at Research Institute of Aquaculture at Nha Trang showed that the highest final weights were obtained with crabs fed a diet containing 43% crude protein and 15% lipid. Furthermore, it was shown that up to 25% of fishmeal in formulated diets could be replaced by either krill meal or soybean meal without significantly reducing growth performance. Pilot pond trials were then conducted at Nha Trang to determine if diets developed using the intensive culture systems could be applied to semi intensive pond culture systems typically used in commercial crab culture in Southeast Asia. The studies showed that growth equivalent to that achieved using trash fish can be obtained with the formulated diets. Significantly the final weights of crabs grown in pond environments were 8-10 times higher than those grown for an equivalent period in the intensive culture systems. Apparently additional natural nutrition available in pond environments promotes the higher weight gain, and the scientists are now studying how they can obtain growth equivalent performances from the intensive culture.

Lobster aquaculture in Vietnam relies on the collection of wild seed (eggs), but they have high rates of mortality in caged grow-out facilities. An extensive study is revealing much about the ecological impact of lobster seed collection and seasonal incidence of breeding in caged lobsters. Studies are under way to determine how to reduce post-capture losses of these seed lobsters, to develop less polluting methods for cultured lobster grow-out, and to optimise lobster feeds and feeding schedules.

Small-scale aquaculture of **freshwater species in the Mekong regions** in Vietnam (and also Cambodia) is a potential important source of income for villagers. But costs associated with feed and feeding, along with limited availability of suitable feed ingredients have limited development. A project to identify prospective feed ingredients has collected a range of samples for an ingredient database. The digestible value of eight key ingredients has been determined, providing valuable guidelines for future feeding. This project will have the added bonus of making a major impact on the catfish industry in the Mekong Delta, where there have been rapid moves away from farm-made feeds to commercially extruded diets and from river-based cages to ponds. Total production of catfish is now approximately 415,000 tonnes/year—a yearly increase of more than 100,000 tonnes since the project commenced.

A new initiative is exploring the potential for **culturing bivalve molluscs** such as native clams, mussels and oysters. A project just under way is looking at how to better utilise this resource for Vietnam, which despite its 3000-km coastline trails its Asian neighbours in production. China has moved from gathering natural seed to hatchery-produced seed, and this project will attempt to emulate that success in Vietnam with a guided program of training and potential species evaluation to develop bivalve hatcheries.

Smallholder farmers supply 80 per cent of all pigs in Vietnam, but the long-term viability of production is threatened by the high cost of feeds, most of which are imported. A project is exploring the feasibility of **feeding cheaper local feedstuffs**. One possibility is meal made from rubber seed, but it contains considerable amounts of cyanide when harvested fresh. The project has developed a

protocol that successfully removes virtually all the cyanide, but further testing is needed before digestibility and feeding studies of this highly nutritious product take place. Another possible source of feed is the residue left after processing cassava to remove the starch. The project team has visited a number of cassava-processing plants, and believe that once the matter of cyanide has been settled there is potential to modify the plants to commercially process the rubber seed. Pig feeding studies with cassava residue have provided information on the nutritional value of this by-product and the levels at which it can be effectively and safely used.

Demand for beef products is rising in Vietnam, and cattle rearing and finishing are considered the top priority for smallholders in Quang Ngai Province. A project is helping to establish **year-round feeding options** by cataloguing available feeds and their nutritive characteristics. Two feeding experiments have provided data on liveweight gain responses to different combinations of forage and locally available concentrate supplements. Verification of feeding options has involved working with farmers in Hanh Phuoc commune. A participatory approach has given those farmers involved a sense of ownership and increased their level of commitment. Results of this study indicate improved weight gains, with the farmers agreeing that the technologies are easy to implement and profitable for them.

In a related activity in Quang Nam Province, an ACIAR initiative is augmenting the World Vision Vietnam Area Development Plan by **training World Vision staff and community leaders** to administer and manage projects to improve cattle productivity. Extension staff in the district and communes are gaining technical and extension knowledge, so that they can help local people to adopt the more productive technologies.

Lack of water hampers agricultural development in the coastal provinces of central Vietnam; also sandy soils near the coast are highly permeable and infertile. An ACIAR project just commenced is designed to increase farmers' incomes by improving the productivity of horticultural crops such as cashews. It is introducing technologies that enable **efficient use of water and nutrients**—nutrient management strategies can minimise leaching losses, particularly in areas with shallow groundwater. The project is focusing on getting the most from wet–dry seasonal climates. In particular it is trialling partial root zone wetting and drying (PRD), a highly efficient irrigation technology that to date has not been evaluated in wet–dry season climates. The project is also helping to build the technical capacity of the Agricultural Science Institute for Southern Coastal Central Vietnam, which is being developed as the main research and extension centre for central coastal Vietnam.

5.5 Facing the future for Vietnam's reservoir aquaculture

ACIAR has supported a suite of initiatives over the past decade that aim to improve fish production from inland water bodies in Asia and Australia. They have studied both larger perennial systems and smaller seasonal water bodies.

The first Vietnam project started in 1998. It highlighted several areas for potential research and led to the development of two new linked projects. One, a technical activity within the Fisheries Program, concerned culture-based and capture fisheries development and management in reservoirs in Vietnam, and focused on improving the fish yield from small-to-medium sized farmer-managed systems as well as larger reservoirs.

The other, within the Agricultural Development Policy Program, focused on the economics of developing reservoir aquaculture in Vietnam and looked at how to help local fisher and farmer communities by increasing the economic value of such fisheries.

The first project introduced local communities in northern Vietnam to knowledge-based management of cultured fisheries in small reservoirs. Outcomes included determination of best fish species combinations to grow in the reservoirs, effectiveness of staggered harvesting, and use of manures added to the water to increase yields.

The project team believes that the research results have led to attitude changes among stakeholders and more ready adoption of culture-based fisheries in reservoirs. Project members have also been instrumental in convincing Vietnamese government institutions to recognise fisheries resources as integral to reservoir functions, leading to development of line agencies for their management.

The project found little evidence of environmental impact of the present culture-based fisheries, which is not surprising since fish stocks are currently fed primarily on natural food with extremely low input of supplemental feed. The environmental impact of cove culture on capture fisheries in large reservoirs is less clear, because cove areas are important as feeding, nursery and spawning grounds for capture fisheries. The whole situation may change dramatically as the Vietnamese government works towards its target of lifting current production of 20,000 tonnes to 250,000 t by 2010.

The second project emphasised the economic development path for reservoir fisheries in Vietnam, viewing reservoirs as a multiple-use resource that needed managing to produce the best outcomes for all groups in society. For instance, the importance of water use for electricity generation and farm irrigation could mean that decisions taken by those in charge of them would adversely influence growth of reservoir fish production.

A key element of the project has been the development of the BRAVO model of reservoir aquaculture in Vietnam. This model, which is underpinned by biological and economic data, has provided useful insights into the potential profitability of reservoir culture and the need to strengthen institutional arrangements for reservoir leasing and credit arrangements. The 'risk' version of the BRAVO model has already developed risk profiles of reservoir aquaculture and defined the scope to improve profits and reduce income variability.

6 Annual Operational Plan 2007–08

6.1 Key performance indicators (2007–08)

- Linkages between ACIAR-funded research and AusAID-funded development continues to be fostered
- New training and information exchange activities in biosafety and biotechnology regulation undertaken
- NGO and community organisation linkages established in at least three projects, including enhancing the role of women in production and utilisation of horticultural crops
- Programmatic shift to emphasis on better processing technologies for two timber species leads to development of higher-value forest products
- Enhancement of quarantine capabilities in fumigation and plant disease diagnosis
- Enhancement of Vietnamese capacity in aquaculture of high-value species (encompassing shrimps, mud crabs and oysters)
- 40% of new projects designed to have significant farmer or policymaker impacts within five years of completion

6.2 Medium-term strategy

ACIAR's Vietnam strategy emphasises research to assist the enhancement of smallholder incomes. This is achieved through fostering the development of higher value crop and livestock products, as well as improving market access through the improvement of the safety and quality of agricultural products and strengthening biosecurity. The latter is particularly important following the accession of Vietnam to the World Trade Organisation. Fisheries research cooperation will focus on aquaculture and mariculture, while forestry cooperation will have an increased emphasis on higher value products

and value-addition. Natural resource management research will focus on sustainable cultivation systems for poor soils in central Vietnam and on water conservation. More rapidly responsive approaches to work on commodity-specific policies, markets and rural adjustment will be trialled. Close linkages to AusAID-funded programs (Collaboration for Agriculture and Rural Development (CARD) and the Quang Ngai Rural Development program) will continue.

6.3 Position

ACIAR's program in Vietnam commenced in 1993 and, since that time, a significant program in forestry, land and water resources, animal sciences, crop sciences, fisheries and postharvest technology has emerged. While training remains very important there has been an evolution from a predominant emphasis on capacity building to one of practical farmer and policy impact.

Some successes include improvements to rice–shrimp farming, integration of mangrove forestry and shrimp production, improvements to inland pond and small reservoir culture fisheries, introduction and dissemination of improved pig breeds, non-chemical rodent control in rice crops, fast-growing acacias, introduction of improved acacia forest germplasm, better irrigation management, improved soil fertility management and better control of citrus pests. Some of the technologies arising from these projects are being applied and capacity developed in R&D and extension through the AusAID CARD program.

Several new projects focus on extension or adaptation of outputs from earlier ACIAR projects in Vietnam and elsewhere in the region. While most of ACIAR's program is currently based in greater Ho Chi Minh City and Hanoi because of the location of research institutes and policy-makers and the national relevance of much of the portfolio, at the February 2004 country consultation, and at subsequent meetings during 2005 and 2006, it was agreed that emphasis on central Vietnam, particularly central coastal regions should increase. ACIAR projects will also support the "four pillars" of development for Vietnam, with respect to development of science and technology and the consequences of infrastructure and small-medium enterprise development for agricultural production and marketing. ACIAR will maintain the flexibility to assist Vietnam with "burning issues" such as avian influenza and control of brown plant hopper in rice.

ACIAR will also continue to seek greater involvement of the private sector and NGOs in projects, linkages with other R&D activities and donors, and development of closer linkages between Vietnamese research and extension organisations. There will also be an increased emphasis on implementation of the results of earlier ACIAR-funded research, including developing manuals and other communication materials.

During 2007–08, new project opportunities will be explored in selected areas of agricultural development policy (including biotechnology and biosafety policy), crop protection and horticulture, livestock production, forestry and fisheries.

6.4 Relationship to the AusAID Vietnam strategy

AusAID's program in Vietnam has two strategic objectives. Within the first, 'Broad-based growth by strengthening the governance of the institutions required for a competitive market economy', there is emphasis on two sub-objectives: improved private sector operating environment and the facilitation of internal and international economic integration. Within the second, 'Improved livelihoods for the rural poor focusing on the Mekong Delta and Central Coast', there is emphasis on four sub-objectives: increase rural productivity, develop human capital, reduce vulnerability to environmental and economic shocks, and strengthen the capacity and accountability of government and the participation of the poor in their governance. In 2007-08, assistance will focus on strengthening the governance of institutions required for a competitive market economy and improving the livelihoods of the rural poor.

ACIAR's Vietnam program complements AusAID's strategy in both focal areas by supporting underpinning research and development interventions. Major emphases are on collaborative investigation of better policy options and interventions for meeting market specifications and opportunities as well as technical cooperation to improve market access through the improvement of the safety and quality of agricultural and fisheries products. Although much of the program is necessarily based in Ho Chi Minh City or Hanoi and surrounding provinces because of the location of most of the research institutes and policy-makers, and the national relevance of particular projects, there is strong emphasis on central coastal regions and the Mekong Delta, with half of the projects in the portfolio working in these regions. ACIAR is also integrating its work closely with Government of Vietnam programs and other donors where possible.

6.5 Indicative priorities

ACIAR has a program of consultations with partner countries on a four-year rolling basis to establish priorities for research collaboration. The most recent such consultation with Vietnam was held in February 2004; the full record of consultation is at www.aciar.gov.au under Partner country priorities/Vietnam. In addition, annual consultations are held with partner organisations to discuss program strategies and new projects.

The majority of ACIAR-supported informal and postgraduate research degree training will continue to be delivered within the context of active projects. However, ACIAR will also support short-course training in selected areas, which may include: experimental design and statistical analysis; research management; research monitoring and evaluation; scientific proposal/grant writing and project design; biotechnology (including priority setting and regulatory and biosafety policy); writing for scientific, extension, farmer and government audiences; and collection and analysis of market information.

Indicative priorities are grouped under the following programmatic themes:

Subprogram 1: Increasing market competitiveness of Vietnamese agricultural and fisheries products

A: Better policy interventions for meeting market specifications and opportunities

- Assessment of impacts of trade agreements, including sanitary and phytosanitary standards and market access
- Policy options for optimising market-oriented production to deliver improved returns to smallholders
- Policy and regulatory approaches to underpin the production of genetically modified crops

B: Enhanced quality and reduced losses in crops and forest products

- Enhancement of quarantine capacity (in fumigation and disease diagnosis)
- Management of pests of perennial crops of central Vietnam

- Integration of practical fruit fly strategies with the management of other insect pests
- Reducing preharvest and postharvest losses and ensuring quality in smallholder systems for fruit, vegetables and grains
- Interventions to enhance the safety and marketability of horticultural crops (including indigenous vegetables)
- Improvement of plantation wood processing efficiency, especially for small eucalypts and acacias through small-scale sawing, drying, preservation, and use of composites

C: Competitive and sustainable aquaculture and livestock production

- Cost-effective and environmentally friendly aquaculture feeds
- Profitable and environmentally responsible grow-out technologies for marine cage culture and pond culture in sandy coastal areas
- Transferring existing knowledge from ACIAR fisheries projects in other countries
- Smallholder pig production systems including nutrition, housing, waste management, health and marketing
- Smallholder production of ruminants within crop–livestock systems

Sub-program 2: Optimising water and soil management for sustainable production, particularly on degraded lands in central Vietnam

- Development of technologies for fast-growing forest plantations for high and sustainable productivity on degraded soils
- Use of tree species with high timber and non-timber forest product values for rehabilitation of natural forests
- Sustainable land-use practices and cultivation techniques to develop agriculture and agroforestry on poor sandy soils in central coastal Vietnam
- Application of water-saving technology and nutrient management systems in crop production

7 Projects (summary and progress reports)

7.1 Subprogram 1: Increasing market competitiveness of Vietnamese agricultural and fisheries products

Projects:

A: Better Policy interventions for meeting market specifications and opportunities

Active

AH/2004/040	The epidemiology, pathogenesis and control of highly pathogenic avian influenza (HPAI) in ducks in Indonesia and Vietnam
LPS/2005/063	Improving the competitiveness of pig producers in an adjusting Vietnam market
PLIA/2000/039	Impact of migration and/or off-farm employment on roles of women and appropriate technologies in Asian and Australian mixed farming systems (IRRI)
ADP/2001/066	Strengthening agricultural market information activities in Vietnam
PLIA/2000/165	Facilitating farmer uptake of ACIAR project results: World Vision collaborative program

Concluded

PLIA/2002/103	Enhancing project impact and science capability through ongoing evaluation
---------------	--

Pipeline

ADP/2005/113	Vietnam WTO accession and structural adjustment implications
ADP/2006/145	Impact of changing agricultural markets on small-farm participation and poverty: cases from India, Vietnam, and Indonesia (IFPRI)

B: Enhanced quality and reduced losses in crops and forest products

Active

ADP/2003/060	Implementation of rodent management in intensive irrigated rice production systems in Indonesia and Vietnam
CP/1998/005	Managing pest fruit flies to increase production of fruit and vegetable crops in Vietnam
CP/2000/043	Huanglongbing management for Indonesia, Vietnam and Australia
CP/2002/086	Improving postharvest quality of temperate fruits in Vietnam and Australia
CP/2002/115	Diseases of crops in the central provinces of Vietnam: diagnosis, extension and control
CP/2006/083	Effective phosphine fumigation—technology transfer
CP/2006/084	Targeting crop protection research and development (R&D) towards social change amongst ethnic minority communities in central Vietnam
CP/2006/113	Scoping study to review the role of women and assess constraints in the production of indigenous Vietnamese vegetables
CP/2007/187	Technical support facility for commercialisation of protein bait production in north Vietnam
CP/2007/211	Rice brown planthopper scoping studies in Vietnam
FST/2001/021	Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying
FST/2002/112	Domestication of Meliaceae species in South-East Asia and Australia, particularly management of the problem of <i>Hypsipyla robusta</i> attack
FST/2003/002	Development and evaluation of sterile triploids and polyploidy breeding methodologies for commercial species of Acacia in Vietnam, South Africa and Australia

SMCN/2002/073 Efficient nutrient use in rice production in Vietnam achieved using inoculant biofertilisers

Concluded

CP/2001/027 Adaptation of low-chill temperate fruits to Australia, Thailand, Laos and Vietnam

Pipeline

CP/2006/066 Improving productivity and fruit quality of sweet persimmon in Vietnam and Australia

CP/2006/112 Enhancing the safe production and promotion of indigenous Vietnamese vegetables by women

FST/2007/053 Value adding to acacia and eucalypt bark

C: Competitive and sustainable aquaculture and livestock production

Active

AH/2004/040 The epidemiology, pathogenesis and control of Highly Pathogenic Avian Influenza (HPAI) in ducks in Indonesia and Vietnam

CP/2005/053 Plant disease diagnostic manual

FIS/2000/018 The economics of development reservoir aquaculture in Vietnam

FIS/2000/065 Assessing the potential for low-cost formulated diets for mud crab aquaculture in Australia, Indonesia and Vietnam

FIS/2001/058 Sustainable tropical spiny lobster aquaculture in Vietnam and Australia

FIS/2002/068 Improving feeds and feeding for small scale aquaculture in Vietnam and Cambodia

FIS/2002/077 Improved hatchery and grow-out technology for marine finfish in the Asia–Pacific region

FIS/2006/099 Capacity building and technology transfer in applied population genetics of aquatic species

FIS/2006/144 Strengthening mechanisms to maximise benefits to small-holder shrimp farmer groups adopting better management practices (BMP's)

FIS/2007/014 Dissemination of fisheries reservoir management extension materials in Vietnam

LPS/2002/078 Improved beef production in central Vietnam

LPS/2002/079 Utilisation of local ingredients in commercial feeds for pigs

LPS/2004/073 Capacity building on cattle production at Dong Giang district in Quang Nam Province

LPS/2005/063 Improving the competitiveness of pig producers in an adjusting Vietnam market

Concluded

FIS/2003/003 Stock structure of two important Mekong River carp species (*Henicorynchus* spp.)

Pipeline

FIS/2005/114 Building mollusc hatchery production capacity in Vietnam and Australia

FIS/2005/115 Improved reliability of PCR screening for shrimp diseases in Vietnam

FIS/2006/098 Mud crab aquaculture in Vietnam: feeds and feeding strategies for industry growth

FIS/2006/126 Developing pond aquaculture for sandfish in Asia–Pacific (WorldFish)

FIS/2006/141 Increasing uptake of aquaculture nutrition research in Vietnam

LPS/2006/069 Development of smallholder cattle production in the south-eastern region of Vietnam

AH/2004/040: The epidemiology, pathogenesis and control of highly pathogenic avian influenza (HPAI) in ducks in Indonesia and Vietnam

Bilateral

Overseas Collaborating Countries	Indonesia, Vietnam
Commissioned Organisation	Australian Biosecurity Cooperative Research Centre, School of Veterinary Science, Australia
Project Leader	Dr Joanne Meers Phone: 07 3365 2260 Fax: 07 3365 1255 Email: j.meers@uq.edu.au
Collaborating Institutions	CSIRO Livestock Industries, Australia Research Institute for Veterinary Science, Indonesia Directorate General of Livestock Services, Indonesia National Institute of Veterinary Research, Vietnam Department of Animal Health, Vietnam
Project Budget	\$1,382,214
Project Duration	01/03/2006 to 28/02/2009
ACIAR Research Program Manager	Dr Peter Rolfe

Project background and objectives

The avian influenza epidemic has spread through poultry flocks of Asia starting in 2003 and is still continuing. Countries affected include Thailand, Vietnam, Cambodia, Indonesia, China, Laos, Japan, and Republic of Korea and Asiatic and Central Russia. The outbreaks have been characterised by high mortality in bird flocks and reflect the ability of the influenza virus to genetically vary over time to more pathogenic strains, a very unusual feature of this virus strains.

The outbreaks were unprecedented in their scale, geographical spread, and devastating economic consequences for the poultry industry, the domestic and international trade in poultry products and the livelihood of rural farmers. Indirect and significant losses have occurred with mass culling of birds in some countries in an attempt to control the spread of the disease in poultry and in humans. Other and unquantified indirect losses have occurred in unrelated sectors such as tourism and business generally with the scare associated contracting the disease.

Of most concern is the high fatality rate in humans infected from poultry although transmission to humans is apparently quite difficult and therefore limited. Regardless deaths have been reported in most countries where the avian disease is present. A more general concern is that human to human transmission may occur and if the disease is as severe as

current cases then a global pandemic is predicted with large number of deaths.

It is not clear whether or not ducks were the initial source of the HPAI H5N1 virus, but it appears very likely that they play a central role in the maintenance and transmission of the virus to chickens and perhaps people.

As such, understanding the biology and epidemiology of the HPAI H5N1 virus requires knowledge of the response to infection with the virus, including the length of time that ducks shed the virus, the sites of virus replication and excretion, and the prevalence of both antibodies (indicative of past exposure) and virus (indicative of current infection) in duck populations. It is also not understood how effective current vaccines are in ducks whether virus continues to be shed into the environment.

The project has five major objectives:

1. to determine the epidemiological characteristics (e.g. seroprevalence, duration of virus shedding) of HPAI H5N1 virus in small holder duck production systems in Indonesia and Vietnam
2. to understand the role of ducks as maintenance hosts and amplifiers of H5N1 virus during and after infection
3. to understand the pathogenesis of HPAI H5N1 infection in ducks

4. to evaluate the efficacy of current vaccines in ducks and determine the possible role of vaccination in reducing virus load and shedding in ducks
5. to develop recommendations for an epidemiological monitoring system which will enable policy making for effective control strategies against HPAI H5N1 virus.

The objectives will be achieved through a combination of field and experimental activities. A survey will be conducted on ducks in intensive production systems and in small holder farms, and including vaccinated and unvaccinated flocks, to determine the prevalence of past and present infection with the H5N1 virus. Challenge experiments of vaccinated and unvaccinated ducks will be performed using strains of H5N1 virus isolated in Indonesia. These will determine tissue tropism, duration of viral excretion and pathogenicity of the virus for ducks. Collation and analysis of data generated from the field and laboratory studies will allow development of action plans and ongoing monitoring systems, resulting in more effective control strategies.

Project Progress

Year 1 (01/03/2006-28/02/2007)

Objective 1. To understand the epidemiology of highly pathogenic avian influenza (HPAI) H5N1 virus (e.g. seroprevalence, duration of virus shedding) in small holder duck production systems in Indonesia and Vietnam)

This objective will be achieved through field investigations. The field sites are located in Java in Indonesia and in the southern provinces of Vietnam to coincide with the largest duck populations and where there has been evidence of HPAI infection. A survey strategy for a longitudinal study that provides statistical confidence and considers the cost of sampling and the resources available was developed together with staff of the research organisations in Indonesia and Vietnam.

An appropriate study design has been chosen and the sample sizes were estimated. Sampling frames were developed and study units from these sampling frames selected. In both countries 16 villages are involved in the study. A total of 80 duck-owning households in Vietnam and 96 duck-owning households in Indonesia were selected and farmers will be interviewed at two-monthly intervals over a period of 12 months. In addition blood samples and cloacal swabs will be collected from ducks and chickens and tested for haemagglutination inhibition antibody titres and for H5N1 viral RNA by real-time PCR.

Collaborating staff and sample collectors were trained in data collection, which commenced in Indonesia in March 2007 and in Vietnam in May 2007.

In addition in Vietnam a case-control study was conducted to identify risk factors associated with the HPAI outbreaks in the Mekong Delta from December 2006 to January 2007. A questionnaire was developed to investigate these outbreaks in five affected provinces and to collect information about potential risk factors for the emergence and spread of HPAI. In total 23 case farms were selected, along with 46 respective control farms. The questionnaire data was collected in February/ March 2007. The data obtained are currently being analysed.

Objectives 2&3. To understand the role of ducks as maintenance hosts and amplifiers of H5N1 virus during and after infection, and to understand the pathogenesis of HPAI H5N1 infection in ducks

The first activity under these objectives is the isolation of HPAI H5N1 viruses in Indonesia and Vietnam from samples collected in the longitudinal studies. Discussions have taken place, reagents purchased and personnel selected to undertake this activity in each of the research institutions in Indonesia and Vietnam.

LPS/2005/063: Improving the competitiveness of pig producers in an adjusting Vietnam market

Multilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	International Livestock Research Institute, Kenya
Project Leader	Dr Stephen Staal Phone: +254 20 4223000 Fax: +254 20 4223001 Email: s.staal@cgiar.org
Collaborating Institutions	University of Queensland, Australia Institute of Policy and Strategy for Agriculture and Rural Development, Vietnam International Food Policy Research Institute, USA Oxfam GB, Vietnam
Project Budget	\$777,593
Project Duration	01/04/2007 to 31/03/2010
ACIAR Research Program Manager	TBA

Project background and objectives

In Vietnam demand for pork is increasing rapidly, due to income and urban growth. Consumers are also looking for better quality. A dual market structure is emerging—a few large-scale farms using higher-yielding technology packages, and a large number of smallholders using less sophisticated systems.

Recent research in southwest China, the Philippines and northern Vietnam has shown that smallholders using improved technology to produce quality products can successfully compete with larger farms in higher-priced markets. Thus successful commercial smallholder pig farming alongside large-scale pig industry may serve as a vehicle for alleviating the widespread rural poverty in Vietnam. But researchers first need to identify pragmatic options to meet the technology needs, facilitate institutional arrangements and provide policy support for poorer producers, thus helping them to gain access to quality inputs and services.

Various formal and informal institutional forms and contracts are evolving. They are suitable for input suppliers, marketing and processing firms, and pig-raisers, but it is unclear what institutional processes will best encourage smallholder access to high-value market chains. Thus the Ministry for Agricultural and Rural Development has sought international assistance to help it develop an appropriate policy and institutional framework.

The overall aim of this project is to identify options for technology, policy, and forms of market institution or coordination, that will give smallholder pig producers in Vietnam better access to higher-value market chains and thus help them to raise their incomes.

Project Progress

Year 1 (01/04/2007–31/03/2008)

First progress report due in 2008.

PLIA/2000/039: Impact of migration and/or off-farm employment on roles of women and appropriate technologies in Asian and Australian mixed farming systems

Multilateral

Overseas Collaborating Countries	Philippines, Thailand, Vietnam
Commissioned Organisation	International Rice Research Institute, Philippines
Project Leader	Dr Thelma Paris Phone: +63 2 845 0563 , 844 3351 ext 312 Fax: +63 2 891 1292, 845 0606 Email: t.paris@cgiar.org
Collaborating Institutions	Curtin University of Technology, Australia Khon Kaen University, Thailand Cuu Long Rice Research Institute, Vietnam
Project Budget	\$496,764
Project Duration	01/01/2004 to 31/12/2007 (Project extended from 01/07/2007 to 31/12/2007)
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

Migration from farms, either to seek off-farm employment as an income supplement or to move to areas for greater opportunities is common throughout much of Asia. Off-farm employment is seen as a way to boost income particularly in smallholder family owned farms. This may increase income but at the cost of reduced farm labour inputs and the likelihood of reduced farm output. Increasing economic pressures from trade liberalisation, globalisation and their impacts, together with constraints from environmental, disease and weed pests and water availability are increasing trends to migrate and or to work off-farm.

The wider these pressures and their effects are felt, the greater the probability of reduced farm productivity impacting on the broader economy. The main group involved in migration and increasingly off-farm employment is men. This is resulting in far-reaching changes to household structures, and in cases of long-term or permanent migration, economic and social changes. Women are increasingly being left with the task of farm management, including having to overcome production constraints, mainly from lost labour inputs of husbands, brothers and other male workers.

Such changes are also occurring in some farming communities in Australia, creating many of the same issues. Little research has been done regarding these changes, their impacts and farm management. Of particular interest are technologies that can be used to alleviate production constraints caused by labour shortages, to help women in Asian and Australian farming systems to manage farms.

The overall goal of this project is to better understand the changes occurring in rural agriculture in Asia and Australia in relation to the changing role of women as a result of off-farm employment and/or migration and the ways in which constraints and needs differ between male and female household heads. In particular, the project will identify possible strategies and technologies to help women heads to better manage farms.

Project Progress

Year 3 (01/01/2006–31/12/2006)

This year, the project accomplished the following objectives: 1) assessed the impact of family migration/off-farm employment on agricultural productivity, farm efficiency, women's empowerment and the changing roles of women at the household and farm level; 2) examined key constraints faced by women heads and other poor women in increasing their productive capacities; 3) identified on-farm strategies and technologies that could help address these constraints; 4) tested and evaluated the identified strategies

ACTIVE PROJECTS

and interventions through participatory approaches; 5) communicated/disseminated information to stakeholders, including women, farm households, research institutions, government bodies and NGOs.

To achieve Objectives 1 and 2, 800 farm households (with and without migrants) were interviewed in each collaborating country (Philippines, Thailand and Vietnam) using a structured questionnaire. Probit analysis was used to identify the factors which determine the probability of a family member to migrate. Ordinary Least Square (OLS) was used to determine the impact of migration, socio-economic factors and farm variables on household income.

In the three countries, the share of remittance earnings to household income ranged from 20 to 50% with the highest share in the Philippines which showed high incidence of international migration. Remittance earnings were spent mainly on food, children's education, debt repayments, and farm inputs. Although remittance earnings helped prevent further income erosion of poor farming households, the pressure to maintain rice yields are shouldered by the family members left behind, particularly the female members. Maximum Likelihood Estimate (MLE) was used to determine the impact of migration on rice productivity and farm efficiency.

In-depth surveys of 200 farm households, a subset from the 800 households were also conducted to determine changes in gender roles as a result of labour out-migration, women's decision-making authority in household and farm-related matters and constraints women farmers face in the absence of men. Women's Empowerment Index was developed to assess women's decision-making authority compared to men. WEIs were found to be higher among households with migrants than those without migrants. Wives are compelled to make 'on-the-spot' decisions when husbands are away on a long-term basis. Their roles have begun to shift from unpaid family workers to de facto farm managers.

Traditionally, women manage the allocation of cash for household expenditures. However, with male absence, they are now getting involved in allocating the limited budget for farm inputs as well. Constraints to increasing women's productive capacity were lack of access to technical knowledge in all aspects of rice production, particularly in the efficient use of

inputs and reducing the costs of rice production. Majority of the women have not received any training in relation to new methods of crop/farm management.

On-farm strategies, technologies and training needs were identified through focus group discussions conducted in the villages. Participatory action research (PAR) included testing and evaluation of improved rice production and post harvest practices with emphasis on seed health and pest management in the Philippines, use of biofertiliser, golden snail control, use of bio-insecticide in Thailand and rice pest management such as IPM (Vietnam).

Women cooperators were trained in the use of these technologies. In Vietnam, before the training, women were given tests on their existing knowledge on pest identification, weed management, cultural practices to maintain healthy plants, reduce inputs and high yield as well as the methods of pest control. Leaflets (about 1000) which include the important roles of women in rice farming were also distributed in the communes and villages. Training materials were developed with the help of Director of Extension Center at Cu Ulong Rice Research Institute (CLRRI) as well as other specialists. Women participants were given T-shirts with slogans on the front 'Phu Nu Tao Dung Tuong Lai' which means 'Women are keys to a better future'.

In Australia, the project completed the review of literature, conceptualized action research and conducted workshops and road shows. These workshops were conducted to communicate research results of surveys, to introduce action research and determine on-site needs. One milestone of the project is the organization of a training course for WiRL (Women in Rural Leadership) which aims to develop a pathway for women to increase women's participation, representation and leadership by developing essential skills for rural women that will lay the foundation for future leadership roles in their own farm business, communities and in agribusiness and influential organizations. This course given in Esperance was successful. There is a demand for other areas and have received invitations to hold WiRL in the wheatbelt, MidWest Bunbury and Kimberley.

ADP/2001/066: Strengthening agricultural market information activities in Vietnam

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	University of Western Australia, Agricultural and Resource Economics, Australia
Project Leader	Dr Donna Brennan Phone: 08 6488 2514 Fax: 08 6488 1098 Email: donnabrennan@iinet.net.au
Collaborating Institutions	Institute of Policy and Strategy for Agriculture and Rural Development, Vietnam Department of Agriculture and Food, Western Australia, Australia Australian National University, Australia Central Institute for Economic Management, Vietnam
Project Budget	\$463,638
Project Duration	01/01/2003 to 30/09/2007 (Project extended from 01/07/2005 to 30/09/2007)
ACIAR Research Program Manager	Dr Simon Hearn

Project background and objectives

Vietnam faces many challenges in the area of agricultural marketing but lacks experience and capacity in market-based research. This project is developing a framework to analyse agricultural marketing issues. Researchers are describing (and quantifying) the current marketing channels for pigs, vegetables and canned fruit in Vietnam, and identify the role of the public and private sectors in marketing these products. They are also comparing the experiences of public and private agricultural marketing services in China, Thailand and Australia with the situation in Vietnam. The researchers are working with the Information Centre for Agriculture and Rural Development – the market research and market information unit of Vietnam’s Ministry of Agriculture and Rural Development – to determine how the Centre can provide ongoing market information services to these and other industries.

Project Progress

Year 4 (01/01/2006–31/12/2006)

Annual report not yet submitted by the Commissioned Organisation.

PLIA/2000/165: Facilitating farmer uptake of ACIAR project results: World Vision collaborative program

Bilateral

Overseas Collaborating Countries	Laos, Thailand, Vietnam
Commissioned Organisation	World Vision Australia, Australia
Project Leader	Mr Jonathon Treagust Phone: 03 9287 2509 Email: jonathan.treagust@worldvision.com.au
Collaborating Institutions	World Vision of Vietnam, Vietnam Laos World Vision Foundation, Laos World Vision Foundation of Thailand, Thailand Queensland Department of Natural Resources and Water, Australia
Project Budget	\$1,452,769
Project Duration	01/01/2001 to 31/12/2007 (Project extended from 01/01/2004 to 31/12/2007)
ACIAR Research Program Manager	Dr John Skerritt

Project background and objectives

Soil Fertility for Sustainable Agriculture in Bac Binh District, Binh Thuan Province, Vietnam is an extension project. In the previous phase of the project, soil was surveyed and the constraints for agricultural production were identified. Technologies to improve the soil fertility and increase crop yields with suitable fertilisation were tested.

This new phase aims to strengthen farmers' understanding of the management of soil fertility and how to apply appropriate fertiliser regimes for some key crops (rice, corn, peanuts) as well as making the technology easily available. Treatments which proved to be effective in the first phase of the project are now being made available to farmers, focussing on upland soils and making the technology easily accessible to participating farmers.

Project Progress

Year 6 (01/01/2006–31/12/2006)

Agricultural lands surveyed in Bac Binh appear poor in organic matter and available nutrients. It has been discovered that soils have a low capacity for cation exchange and the local climatic conditions of dry, hot weather leads to serious soil degradation and desertification.

The project has continues carry out activities including:

1. consolidating and packaging the knowledge on soil management gained during the initial project period
2. building the capacity of district and commune partners to develop and apply knowledge on soil management
3. engaging an expanded number of local farmers to use recommended soil management techniques to improve agricultural yields
4. pilot testing appropriate water management technology.

Research shows that balanced use of fertilisers (N, P, K) for crops improved plant growth and increased yields, yet the local farmers had poor knowledge of soil fertility and fertiliser use. Limited liming and application of farm yard manure (FYM) is traditional the used practices. Urea has been the only fertiliser used to enhance soil nitrogen content. Phosphate and potassium have also been added to crops to a very limited extent. Farmers limited knowledge on the quantities and timing of fertiliser application has led to low income for farmers.

Research has also shown that liming and organic manure application can remarkably increase crop yields. Field trials in the spring season of 2005 found that, gross benefit return provided by improved fertiliser use, could be significantly increased for corn and peanuts when compared to traditional farmer practice. In order to demonstrate and transfer technologies to farmers, field trials on fertiliser application for cropping systems in the problem soil areas were implemented in 2006 via a participatory method in selected communes. Building on this same technique, the summer season crops of corn and peanuts were trialled as well.

PLIA/2002/103: Enhancing project impact and science capability through ongoing evaluation

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Department of Primary Industries, Victoria, Australia
Project Leader	Mr Steve Vallance Phone: 03 5092 1322, Mob: 0418 515 468 Fax: 03 5092 1269 Email: steve.vallance@dpi.vic.gov.au
Collaborating Institutions	Ministry of Agriculture and Rural Development, Department of Science and Technology, Vietnam
Project Budget	\$399,352
Project Duration	01/07/2004 to 30/06/2007
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

The Vietnamese Government is increasingly directing budgetary resources to agricultural research and development. As a result there has been a corresponding community increase for accountability and expectations of seeing real outcomes from R&D. What is lacking is a strong evaluation framework to demonstrate and help deliver outcomes. Strengthening both the role and frameworks for evaluation will address this problem. The ability to evaluate a range of R&D projects and their outcomes, including such grey areas as scientific capacity and capability, begins with project planning. Many Vietnamese organisations have little experience in organisational learning and supporting evaluation systems. As a result planning to ensure efficient and effective R&D outcomes is often limited or absent. This is particularly the case with 'fuzzy' or poorly defined concepts and projects. This creates a hiatus between project outcomes and meeting public demand to show outcomes and link them to projects.

In Australia the Department of Primary Industries, Victoria (DPIV) has addressed a similar set of issues, driven by State Government policy priorities. Part of this approach has focused on evaluation tools for emerging impacts of R&D and how these can be applied to guide projects to better outcomes. Mapping outcomes of science capability and capacity has also been addressed through a story approach utilising performance indicators and concept mapping. The DPIV approach will be trialled and tested for its applicability to the Vietnamese context, at the Ministry of Agriculture and Rural Development.

The project is enhancing the impact of agricultural research by MARD and DPIV by developing an evaluation procedure for research and development projects suited to the MARD environment, and by developing a procedure for evaluating science capability.

Project Progress

Year 3 (01/07/2006–30/06/2007)

During this year the project had a range of changes to the Australian staff so was disrupted. The objectives were reviewed and the research team met and agreed on the program to achieve most of the objectives, and it looks like this has been achieved. The group asked for an extension so that the project group including two Vietnamese could attend the Australian Evaluation Association Conference in Melbourne in September 2007. This was agreed to. This facilitated presentation of project results and peer assessment. The final report is being prepared as part of the Conference attendance and will be delivered by the end of 2007.

ADP/2003/060: Implementation of rodent management in intensive irrigated rice production systems in Indonesia and Vietnam*Bilateral*

Overseas Collaborating Countries	Indonesia, Vietnam
Commissioned Organisation	CSIRO Sustainable Ecosystems, Australia
Project Leader	Dr Peter Roebeling Phone: 07 4753 8586 Fax: 07 4753 8600 Email: peter.roebeling@csiro.au
Collaborating Institutions	World Vision Vietnam, Vietnam Plant Protection Department, Vietnam International Rice Research Institute, Philippines South Sulawesi Assessment Institute for Agricultural Technology, Indonesia
Project Budget	\$738,781
Project Duration	01/04/2006 to 30/09/2009
ACIAR Research Program Manager	Dr Simon Hearn

Project background and objectives

In irrigated rice crops, rodents are the number one pre-harvest pest in Indonesia and amongst the top three pests in Vietnam. Rodent pests affect directly the lives of poor farmers in these countries through damage to growing crops, incurring postharvest losses, transmitting diseases to people and livestock, contaminating food and water, and damaging buildings and other possessions. Rodent impacts are greatest among the poorer communities, who have no capacity to absorb either the chronic losses or the occasional acute losses associated with periodic rodent population eruptions.

Two previous ACIAR projects in Indonesia and Vietnam, together with an ACIAR/World Vision project and an AusAID CARD project in Vietnam, have made substantial advances in ecologically-based rodent management. Four detailed reviews of these projects have been very positive and there has been strong recommendation for extending the village focus to a broader geographic scale.

The major objective of this project is to develop effective pathways for delivery and uptake of integrated ecologically-based methods for rodent management in poor farmer communities in the Red River delta and central coastal zone of Vietnam, and in South Sulawesi in Indonesia.

Project Progress**Year 1 (01/04/2006–31/03/2007)**

Project start-up workshops in Vietnam (Ho Chi Minh City, 25 participants) and Indonesia (Makassar, 25 participants) were highly successful and showed strong commitment from project partner organisations and staff in Vietnam and Indonesia. Long term objectives and associated activities were reiterated, detailed annual project plans were developed and case study areas were identified.

Project sites in Vietnam (An Giang and Ha Nam) and Indonesia (South Sulawesi and West Java) have been identified on the basis of discussions with experts, Key Informant Interviews (KIs), Focus Group Discussions (FGDs) and other programs in the area, and have been established in the third quarter of 2006 in Vietnam (seven treatment and seven reference hamlets in An Giang; 13 treatment and six reference hamlets in Ha Nam) and will be established in the first quarter of 2007 in Indonesia. At this first stage of the project treatment sites receive Trap Barrier System (TBS) and/or Community Action (CA) demonstration, extension and information. Note that CA includes ecological rodent management practices like synchronised cropping, timed community campaigns and field hygiene.

ACTIVE PROJECTS

In alignment with the establishment of project sites, detailed baseline information for these sites is collected using Knowledge, Attitude and Practice & Socio-Economic (KAP&SE) household surveys, KIIs and FGDs, which were conducted and entered in the second half of 2006 in Vietnam and will be conducted and entered in the first half of 2007 in Indonesia.

Training for project staff included a 2-day KAP&SE survey development and training workshop in Vietnam and Indonesia, and a 4-day ACCESS data entry training workshop in Vietnam. In addition, the 3rd International Conference on Rodent Biology and Management in Vietnam (Hanoi, 28/8/06 till 1/9/06) provided an excellent opportunity for in-country project leaders to exchange ideas and experiences as well as to present these to the wider scientific community.

Training courses for farmers in Vietnam included eight 1-day workshops on ecological rodent management technologies, to familiarise farmers with the available technologies, their functioning and associated costs. Farmers showed a strong interest in these workshops as evidenced by the number of participants (in total over 600 farmers participated).

Formal linkages to local extension organisations and programs have been strengthened, including linkages with PPD, sub-PPDs and World Vision in Vietnam and linkages with the Assessment Institute for Agricultural Technology (AIAT), sub-AIATs and IIRR in Indonesia. An important additional linkage in Indonesia has been the alignment of the project with the Primatani program, which is a new national program for accelerating dissemination of agricultural production technologies.

CP/1998/005: Managing pest fruit flies to increase production of fruit and vegetable crops in Vietnam

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Griffith University, Faculty of Environmental Sciences, Australia
Project Leader	Professor Dick Drew Phone: 07 3875 3696, mobile 0417 729 356 Fax: 07 3875 3697 Email: d.drew@griffith.edu.au
Collaborating Institutions	Plant Protection Research Institute, Vietnam Fosters Asia, Vietnam Southern Fruit Research Institute, Vietnam Aventis, Vietnam, Vietnam University of Western Sydney, Australia
Project Budget	\$853,890
Project Duration	01/07/2001 to 30/04/2008 (Project extended from 01/07/2005 to 30/04/2008)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Fruit flies are the most damaging invertebrate pests of agriculture throughout Southeast Asia and the Pacific region. They are a major problem in Vietnam, where 70 per cent or more of many fruit crops are lost to fruit fly damage. In addition, the presence of fruit flies in any country adversely affects its trade because of severe quarantine restrictions imposed by importing countries. In Vietnam, the total area planted to horticulture is increasing as part of the government's bid to achieve food security and improve nutrition but, mainly because of fruit flies, productivity remains low and quality is poor. Given the largely benign soil and climate conditions, productivity could be increased considerably. For example, the average yield of oranges per hectare in Vietnam is only 5.7 tonnes, compared to 33.2 tonnes in Australia.

There are at least four main pest species involved in Vietnam, and these attack almost all fruit and many vegetable crops throughout the region. The flies lay eggs under the skin of the fruit and the growth of the resulting maggots destroys the fruit or severely damages it. The country's principal fruits (banana, citrus and mango), most tropical fruit and the recently introduced temperate stone and pome fruits are all attacked.

In an attempt to control the problem, the Vietnamese have been using cover sprays of persistent insecticides. However, chemical residues remain in food products and in the environment. Widespread insecticide use can also kill beneficial invertebrates, such as the natural predators on fruit flies and aphids.

An alternative to heavy chemical usage is the protein bait spray method of control. This consists of attractive protein (a bait for flies) laced with a small concentration of insecticide, sufficient to kill the flies within about 1–2 days. About 50 mL of bait per tree is placed on the leaves. The method is inexpensive and easy to apply (no spraying equipment is required), and has been tested in Australia, Malaysia, Thailand and, recently, parts of Vietnam. The quantity of insecticide added to the environment in this way is negligible. The main requirement is a source of cheap bulk protein, and this will probably come from discarded brewery yeast, the country's main brewery having signalled that it is willing to provide it.

The project is determining the major pest fruit fly species, and their preferred fruits, in each region of Vietnam to introduce suitable pre-harvest control by bait-spraying.

Project Progress

Year 6 (01/07/2006–30/06/2007)

Pairs of male lure traps (methyl eugenol and cue-lure) were set up in provinces that were not surveyed before. These are Kien Giang, Thua Thien Hue, Ca Mau, Tra Vinh, An Giang and Binh Phouc in South Vietnam, and Son La, Thai Nguyen, Tuyen Quang and Ha Giang in north Vietnam. No new species of flies have been recovered so far and the species composition remains the same as for the provinces surveyed in the earlier project. Additional samples of host fruit have been collected to verify uncertain host records.

Trials on peach and plum integrating fruit fly control using spot sprays of protein baits with improved crop management techniques and post-harvest handling introduced through ACIAR project CP/2002/086 – *Improving postharvest quality of temperate fruits in Vietnam and Australia* were planned for various locations in Moc Chau province. However, these trials could not be implemented this year because of high variability in fruiting and fruit load within some of the experimental sites. It is thus proposed to conduct these trials during the next fruiting season in March–June 2008.

In the Mekong Delta, trials were planned to integrate fruit fly control using spot sprays of protein baits with improved control of pests other than fruit flies using white mineral oils introduced through ACIAR Project CP/2000/043: *Huanglongbing management for Indonesia, Vietnam and Australia*. One trial on Barbados cherry has been established to evaluate the effectiveness of integrating SOFRI Protein and methyl eugenol trapping for fruit fly control, and the mineral oil SK Enspray 99 for other such as aphids, mites, scales and mealy bugs. The trial is in progress.

A new protein bait plant has been constructed at An Think Brewery in Hanoi, and the facility was officially launched on 9 May 2007.

The farmer training program is continuing with another 2950 farmers having received training in fruitfly biology and field pest management in the provinces of Hue, Quang Nai, Quang Nam, Lam Dong, Contum, An Giang, Kien Giang, Ca Mau, Soc Trang and Bac Lieu.

CP/2000/043: Huanglongbing management for Indonesia, Vietnam and Australia*Bilateral*

Overseas Collaborating Countries	Indonesia, Vietnam
Commissioned Organisation	University of Western Sydney, Centre for Horticulture and Plant Science, Australia
Project Leader	Professor Andrew Beattie Phone: 02 4570 1287, mobile 0414531879 Fax: 02 4570 1314 Email: a.beattie@uws.edu.au
Collaborating Institutions	Gajah Mada University, Indonesia CSIRO Entomology, Australia Southern Fruit Research Institute, Vietnam Food Crops Research Institute, Vietnam Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement, Vietnam Research Institute for Citrus and Subtropical Horticulture, Indonesia
Project Budget	\$1,089,164
Project Duration	01/01/2003 to 31/05/2009 (Project extended from 01/01/2006 to 31/05/2009)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Huanglongbing is a citrus disease caused by the proteobacterium *Candidatus Liberibacter asiaticus* and spread by the Asiatic citrus psyllid *Diaphorina citri*. The disease is a serious impediment to citriculture in Asia because it can destroy orchards within five years of planting. Huanglongbing was first seen in India and Pakistan in the 1800s, but has been gradually moving eastward through tropical and subtropical Asia.

Despite the application of hazardous and expensive pesticides, the disease has prevented the establishment of viable citrus industries, seriously affecting the welfare of farmers and national economies. It is also a threat to biodiversity through the loss of citrus species and citrus relatives that are endemic to the region. Vietnam and Indonesia are particularly affected.

Complete control of huanglongbing is not possible, but a better understanding of the vector could be used to minimise vector populations and disease transmission, and to optimise the role of natural enemies within sustainable integrated crop management programs.

Huanglongbing and *D. citri* do not occur in Australia, but there is a high risk that they could be introduced by natural and unintentional human-assisted spread through Indonesia and Papua New Guinea on known and possibly alternative hosts.

The aim of the project is to improve citrus productivity in Indonesia and Vietnam by studying the transmission and management of the citrus disease huanglongbing. A further aim is to develop management strategies for the Australian citrus industry in the event that the disease enters Australia.

Project Progress**Year 4 (01/01/2006-31/12/2006)**

In southern Vietnam, studies at the project field site at Cai Be in Tien Giang in the Mekong Delta in which application of mineral oils, pesticides and other management strategies are being compared continued. Guava interplants within the site continued to limit ingress of huanglongbing and its vector, the Asiatic citrus psyllid, into the site.

The level of infection three years after citrus trees were planted reached about 20%. This compares well with about 24% two years after planting in French and Vietnamese studies at Cai Be in which the systemic insecticide imidacloprid was applied initially as soil drenches and then directly to the trunks of trees. The impact of guava on spread of the disease has the potential to radically alter the economics of citrus production in the Mekong Delta, and in similar environments, through additional income from sale of guava fruit, dramatic reductions in pesticide use, and, through increased longevity of citrus orchards, increased income from the sale of citrus fruit.

The impact of guava interplants on spread of the disease has gained worldwide attention. In northern Vietnam, growth of trees at the project field site at Cao Phong, where a similar experiment to the one at Cai Be, but without guava interplants, is being conducted, continued to be slower than in the tropical south. No psyllids were observed within the site during 2006 and symptoms of the disease were not observed. Infestations of the defoliating gold dust beetle (*Hypomeces squamosus*) were, as in 2005, of concern in all treatments. Mineral oil sprays gave good control of citrus leafminer (*Phyllocnistis citrella*).

In Indonesia, plants in all field sites established in late 2004 grew slowly until the end of the extended dry season, and then quite rapidly. No psyllids were observed in these sites at mid (670 m asl) and high (1300 m asl) altitudes. No psyllids were observed in mature orchards at 1300 m asl, or in D-vac samples from these orchards. The major impediments to citrus production at this altitude appear to be propagation on non-disease free plants, and inadequate, but relatively easy, control of heavy citrus powdery mildew (*Oidium tingtoninum*) infections and citrus leafminer (*Phyllocnistis citrella*) infestations.

The diversity and abundance of predatory coccinellid species varied consistently with altitude. The incidence of the predators was highest at the lowest altitude and lowest at the highest altitude. Black citrus aphid (*Toxoptera citricida*) was the main host of the coccinellids, and heavy infestations were observed at all altitudes. Both primary parasitoids of the psyllid were recorded, with the endoparasitoid *Diaphorencyrtus aligarhensis* being more common than the ectoparasitoid *Tamarixia radiata*. The favoured hosts of the psyllid among

20 plant species and cultivars being compared at Purworejo (40 m asl) were, from October 2005 to July 2006, *Citrus × junos*, then *Swinglea glutinosa* and *Murraya exotica*. During the same interval nymphs were most common on *Citrus hystrix*, *M. exotica*, *S. glutinosa* and *Bergera koenigii*. More than 240 adults and 420 nymphs were recorded over the 9 months. At this point, *Murraya paniculata*, as a host of adults, ranks thirteenth among the 20 plant species and varieties in the trial, and no nymphs were recorded on any of the 16 *M. paniculata* plants in the trial.

These results were unexpected, as *M. paniculata* is considered to be the favoured host of *D. citri*, and we are not certain if plants named as *M. paniculata* represent a single highly variable species, a hybrid (*M. exotica*), or two species (*M. paniculata* and *M. exotica*), as the validity of *M. exotica* as a species is uncertain.

However, in our studies, significant differences in morphology and molecular biology were detected between the two species as named and *M. exotica* is growing and flowering more prolifically at Purworejo than *M. paniculata*. These findings are important as it is now clear that *M. exotica* is susceptible to huanglongbing whereas *M. paniculata* is possibly not or is asymptomatic and plants grown as *M. paniculata* in China, Florida and Brazil resemble *M. exotica*.

No psyllids were recorded in the Purworejo where six treatments are being compared for control of the psyllid. However, some 20 sprays have been applied in the oil treatments since late 2004. No oil-induced phytotoxicity has been observed but some minor, not readily noticeable, oil soaking has occasionally been observed along the midveins of mature leaves. Trees in the imidacloprid treatment did not appear to be any better than trees in other treatments.

Citrus greasy spot (*Mycosphaerella citri*) was less common on oil sprayed trees. Experiments in controlled environment facilities at Universitas Gadjah Mada demonstrated that psyllid females can detect mineral oil deposits on treated surfaces before landing, most probably through detection by antennal receptors of volatile oil molecules.
Vietnam

CP/2002/086: Improving postharvest quality of temperate fruits in Vietnam and Australia*Bilateral*

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	NSW Department of Primary Industries, Australia
Project Leader	Dr Shane Hetherington Phone: 02 6391 3860 Fax: 02 6391 3899 Email: shane.hetherington@agric.nsw.gov.au
Collaborating Institutions	Food Crops Research Institute, Vietnam Research Institute of Fruit and Vegetables, Vietnam Queensland Department of Primary Industries and Fisheries, Australia Department of Agriculture and Rural Development, Vietnam
Project Budget	\$766,084
Project Duration	01/07/2004 to 31/12/2007
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Quality temperate fruit such as peaches, apricots, plums and persimmons have been introduced into the cooler upland regions of north-western Vietnam. Ten mountain provinces now grow temperate fruits, their climates having a suitable temperature range to accommodate cool climate fruit trees. The exotic nature of these cool climate fruits in a tropical climate attracts a price premium, but poor quality caused by pre and postharvest losses is limiting this potential.

ACIAR has supported research to improve crop management and to reduce the impacts of fruit fly pests, two main factors in reduced quality.

The Vietnamese Government is supporting infrastructure development, however significant losses of fruit continue. Between 30 and 40 per cent of fruit does not reach market. A substantial amount of fruit is also harvested before ripening to avoid disease and pest losses, but this ensures low quality. Poor transportation processes exacerbate the potential for disease outbreaks postharvest and also result in damaged fruit. Changes in pre and postharvest management can significantly impact on fruit quality and lifespan. Harvesting at the right time will improve quality with fruit fly management strategies likely to reduce the need for harvesting before ripening. The introduction of new cultivars can further limit losses and help create an economically viable industry for poor farmers.

The project is determining postharvest disease and quality management problems associated with the production and distribution of temperate fruits to establish regionally feasible changes to production and postharvest systems that will improve fruit quality and reduce postharvest losses in Vietnam and Australia. Project activities will also improve research and development capacity and extend project results through training activities and farmer linkages.

Project Progress***Year 3 (01/07/2006–30/06/2007)***

Production of stone fruit is regarded as an important component of poverty alleviation in Vietnam's mountainous northwest. Despite relatively extensive plantings of plum and peach and historical success, the benefits associated with production have not yet been fully realised and are, in fact, declining. The likely causes of this decline are inappropriate varieties, poor pre harvest management, complex supply chains and inadequate postharvest handling and marketing.

A survey of growers, collectors, wholesalers and retailers was undertaken to gain a better understanding of current supply chain practices and how they impact on fruit quality. These studies reinforced our belief that the supply chain is very complex but notable results included an indication that quality discrimination is carried out at all stages of the supply chain with 69% of collectors indicating that they liked to purchase large fruit. The majority of collectors also store fruit for 1–2 days to obtain a sufficiently large consignment for shipping.

These findings justify our emphasis on improving fruit quality and shelf life. Postharvest disease also limits supply. The diseases brown rot and grey rot (caused by the fungal pathogens *Monilinia fructicola* and *Botrytis cinerea* respectively) are the most serious diseases and affected up to 13% of fruit this season in Vietnam. A simple postharvest fungicide dipping protocol has been developed which reduces these diseases. Further improvement can be achieved by applying a preharvest fungicide schedule. The use of essential oils derived from cinnamon and lemon myrtle has proven inhibitory toward these pathogens in *in-vitro* and simple *in-vivo* tests. Work is under way to examine the possible use of bacteria and yeasts isolated from peach fruit surfaces as biological control agents.

Fruit maturity indices have now been developed for Tam Hoa plum and Tropic Beauty Peach. It is hoped that this will assist in the timing of fruit harvest to optimise fruit quality and storage. Consumer preference trials undertaken during this year have indicated that our perception of 'correct' maturity may not align with the preferences of Vietnamese consumers who prefer their fruit crunchy, non-juicy and green. The situation may be further complicated because a significant proportion of fruit is bought for religious reasons rather than for eating. A more detailed analysis of consumer preferences was completed during the current Vietnamese fruit season and awaits analysis.

Because fruit production is remote from markets effective transport is critical. Fruit transport in the current industry packaging standard – a 30kg, unpadded cardboard box – results in unacceptable losses. Our trials have shown that a reduction in the size of the package to 10 kg and the inclusion of shredded paper packaging

reduces impacts but this does not translate to greater quantities of saleable fruit. This season a number of new packaging options including rice straw, pine boxes and cardboard liners have been trialled. It should also be noted that earlier studies highlighted the fact that losses prior to harvest can be as high as 28% and improvements in pre-packaging handling will become the subject of future work.

Refrigeration also offers significant quality and storage improvements. For example, 99% of Tam Hoa plums remain saleable after 21 days storage at 10°C and they are firmer than fruit stored at ambient temperatures. This season's trials have examined the feasibility of including refrigerated rail transport as a means of shifting fruit from Bac Ha to the Hanoi markets.

ReTain[®] is a commercial formulation containing the active ingredient aminoethoxyvinylglycine (AVG). During the last two seasons our project has examined the ability of this product to improve harvest management in Tam Hoa plums and Earligrande peaches. Application of ReTain[®] significantly increased fruit size and extended the harvest period. Manipulation of the harvest period allows farmers to target 'market windows' in which they are likely to receive higher prices. In parallel studies in Australia we have been able to demonstrate that ReTain[®] treated fruit can be harvested later, is larger and firmer, and can be stored for longer without storage disorders (e.g. soft tip and flesh bleeding).

A number of key personnel travelled to Australia during this reporting period. Mr Tran Duy Long (FAVRI) visited the Gosford Horticultural Institute to study postharvest management of stone fruit while Mr Vu Duy Hien (PPRI) and Mr Cao Dang Kien (DARD Lao Cai) visited Alstonville Centre for Tropical Horticulture and the Maroochy Research Station to study IPM and crop management.

A large, irrigated planting of low chill peach, plum and nectarine trees was established at Bac ha Research station to aid future extension and research activities.

CP/2002/115: Diseases of crops in the central provinces of Vietnam: diagnosis, extension and control*Bilateral*

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	University of Sydney, Faculty of Agriculture, Australia
Project Leader	Professor Lester Burgess Phone: 02 9351 2526 Fax: 02 9351 6481 Email: l.burgess@agec.usyd.edu.au
Collaborating Institutions	Royal Botanic Gardens, Australia Hanoi Agricultural University, Vietnam Hue University of Agriculture and Forestry, Vietnam Quang Nam Provincial Plant Protection Sub-Department, Vietnam Research Centre for Medicinal Plants, Vietnam Nghe An Provincial Plant Protection Sub-Department, Vietnam Ministry of Agriculture and Rural Development, Vietnam
Project Budget	\$499,940
Project Duration	01/01/2005 to 30/06/2008
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

The Central Vietnamese provinces of Quang Nam, Quang Tri, Hue and Nghe An grow a variety of crops, including coffee, pepper, watermelon, sugar, citrus and durian. Yields of these, and other crops, are falling due to disease. Soilborne fungal agents are the main disease carriers and cause. Fungal diseases are particularly difficult to accurately diagnose without laboratory support, however the central provinces lack diagnostic capabilities and laboratories. The agro-climate of the central region is conducive to the spread of fungal diseases, with effective control dependent on diagnosis.

Previous research supported by ACIAR has significantly built diagnostic and laboratory capacity, but at Hanoi. This expertise has not been extended to the provincial level. As a result scientific and farmer control options are limited. With coffee, black pepper, watermelon and pineapple all export crops and the first two of increasing value, there is a need to protect against further yield declines from fungal diseases by enhancing diagnostic capacity.

The overall objective is to improve farm incomes in the central provinces of Vietnam by reducing yield loss from fungal diseases. This reduction will be achieved through the development and promotion of appropriate control measures, to:

- develop the capacity at provincial level to diagnose fungal diseases;
- extend information on these diseases through participatory farmer training;
- develop control measures in collaboration with farmers.

Project Progress***Year 2 (01/01/2006–31/12/2006)******Objective 1: Training of provincial staff in basic laboratory diagnostics***

Two workshops were held in Quang Nam, in January and April 2006 for seven staff from all three provincial Provincial Plant Protection Sub-Department (PPSD's) and Hue UAF. Each of these workshops involved disease surveys of key crops, diagnostic training in the laboratory and farmer consultation, focusing on ginger, peanuts and the major vegetable crops. The surveys also contributed to Objective 3.

ACTIVE PROJECTS

These two workshops also integrated English training with the formal training in diagnostics and field work. English support was provided by Mrs Jillian Burgess and proved very successful. We can now communicate reasonably well by email directly with five of the seven young laboratory staff. Equally importantly they can now make some use of the written resources provided in English. Australian team members can now interact directly with two of the three provincial centres (Quang Nam and Hue).

Five district staff from Quang Nam were included in the April Workshop. Their involvement was invaluable as they will be involved in the long-term delivery of advice on plant disease directly to farmers. They were enthusiastic and proved quick to learn laboratory skills. All were recent graduates. One of the district staff has now joined the Quang Nam project team! The third intensive workshop was initiated on December 26 and was completed on 27 January 2007. Again English training was integrated into the diagnostic and research training.

Objective 2: Establish basic fungal diagnostic laboratories

Completed as originally planned. Savings on travel expenditure were allocated to the provision of some basic equipment to establish a small laboratory at Hue PPSD where two staff have been trained in our program. This decision followed a request from these staff and their Director and was made in consultation with the Project Leader, Vietnam.

Objective 3: Implement limited surveys of nominated fungal diseases

In the previous annual report we gave details of surveys and findings on quick wilt of black pepper and pineapple heart rot. An intensive survey of ginger wilt in Quang nam was initiated in December 2006, involving all team members from the three provinces. Invaluable discussions were held with farmers who advised that they recognised two types of symptoms, 'one where the plants appeared to have boiled in water' and collapsed within a few days, and the other one where plants yellowed and wilted very slowly. Subsequently the bacterial wilt pathogen *R. solanacearum* was detected using a Pocket[®] diagnostic test kit and suspected cultures of the pathogen were isolated. This pathogen is thought to cause the 'boiled water' symptom. The yellowing (slow wilt) was linked to *Fusarium oxysporum* known to be a pathogen of ginger in other countries. Root knot nematode was also

discovered on ginger and was most common where *F. oxysporum* was isolated commonly. This nematode has been shown to increase the incidence of *Fusarium* in wilt in some crops in other countries. A preliminary survey of gummosis in watermelon indicated that *Didymella* sp. is the pathogen responsible for this disease in Hue. Dry conditions in Quang Nam prevented disease development.

An intensive survey of potential root-rot fungal pathogens of peanuts seedlings was initiated in December in Quang Nam involving the whole team. The initial results indicated *Pythium* species were the dominant pathogen species, together with *Rhizoctonia* sp. and *Aspergillus niger*. The seedling survey and a survey at mid-pod stage will be conducted in each province in March and April/May respectively. *Phoma terrestris* (pink root rot pathogen) was identified causing losses in Vietnamese onions in Quang Nam province following requests for advice from farmers. This is the first report of this disease.

Further study on coffee decline indicates that the problem may be a consequence of termite damage of the bark of the upper tap root and lower stem, which facilitates infection by fungal pathogens which then develop a slowly spreading root rot. *Pythium* species and *Phytophthora* species were found in nursery transplants of several vegetable seedlings. This raises issues for disease management.

Objective 4: Establishment of farmer reference groups and participatory training/liaison activities

Invaluable discussions have been held in the field with farmers on each of the major diseases being considered. The Quang Nam PPSD has been working with 50 vegetable farmers to promote the adoption of fungicide application for the control of *Scleroteria* stem rot in beans, together with rotation. Discussions were held with ginger growers about the problem of contaminated rhizomes used for planting. Plans were also discussed to assess the feasibility of field trials for different heart rot and quick wilt of black pepper.

Objective 5: Pathogenicity tests of cultures from surveys

Pathogenicity tests of the putative pathogens from ginger are planned for 2007. However a supply of pathogen-free ginger has not yet been identified. Note that pathogenicity for *Phytophthora capsici* to black pepper, and *P. nicotianae* for pineapple heart rot were completed across 2005–2006. *Didymella* sp. was shown to cause gummosis in watermelon in a preliminary test. The provision of a supply of pathogen-free coffee seedlings is an issue.

Objective 6: Implement field trials to evaluate control measures

Field trials on control will be implemented in 2007 for pineapple heart rot, quick wilt of black pepper and the wilt complex in ginger. As diseases of vegetables and field crops are identified during diagnostic training, advice is extended to farmers, if the control measures are well established in other countries. Crop rotation and the development of pathogen-free transplants, rhizomes etc. will be highlighted in training and extension activities.

Objective 7: Production and distribution of model teaching materials. Dissemination of findings formally and in-country

Discussions have already been held with the project team to initiate ideas on extension materials.

CP/2006/083: Effective phosphine fumigation - technology transfer

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Farming Systems Institute, Australia
Project Leader	Dr Patrick Collins Phone: 07 38969433 Fax: 07 38969446 Email: pat.collins@dpi.qld.gov.au
Project Budget	\$60,000
Project Duration	01/01/2007 to 31/12/2007
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

ACIAR project PHT/1998/137 developed national phosphine fumigation standards to control insect infestation in stored grains in Vietnam – essential to support Vietnam's growing export trade, ensure food security within the country and underpin effective quarantine protocols.

The team at the Plant Quarantine Diagnostic Centre in Hanoi that developed the standards will begin to implement them in this new project – first through a national program to train officers from three key phosphine user groups: Vietnamese Department of National Reserve (managers of the national grain reserve); commercial fumigation companies (responsible for the fumigation of export commodities); and Provincial Plant Protection and Regional Plant Quarantine Sub-departments.

Project Progress

Year 1 (01/01/2007–31/12/2007)

First progress report due in 2008.

CP/2006/084: Targeting crop protection research and development (R&D) towards social change amongst ethnic minority communities in central Vietnam

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	University of Queensland, School of Journalism and Communication, Australia
Project Leader	Dr Elske van de Fliert Phone: 07 3381 1411 Fax: 07 3381 1416 Email: e.vandefliert@uq.edu.au
Collaborating Institutions	Queensland Department of Primary Industries and Fisheries, Gatton Research Station, Australia Vietnam Women's Union, International Cooperation's Department, Vietnam
Project Budget	\$87,913
Project Duration	01/02/2007 to 20/09/2007 (Project extended from 01/09/2007 to 20/09/2007)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

In Vietnam, agricultural R&D has not been closely connected with the country's rural development programs. This project will train selected Vietnamese R&D practitioners in how to tailor research and development agenda-setting and output to suit the needs of ethnic minority communities in the Central Highlands – with a focus on crop protection.

Activities include: (a) a needs and opportunity assessment study involving the communities and community-based organisations working with them; (b) a study identifying appropriate research partners in Vietnam for follow-up participatory research; (c) the design and implementation of a training workshop on participatory research and dissemination. The project should assist the development of an R&D program that targets the crop and pest management needs of these communities.

Project Outcome

Year 1 (01/02/2007–30/09/2007)

While rural development in Vietnam has been truly impressive over the past decades, strategies applied emphasising economic growth have mainly worked for those communities in potential lowland areas where farming is well linked into market mechanisms. Ethnic minorities communities located in remote and marginal mountainous areas have largely been unable to hop on the bandwagon mainly as a result of a communication disconnection with the mainstream forces of development. Appropriately tailored interventions are needed to address the specific problems, needs and situations of minority communities.

The SRA team conducted a needs and opportunity assessment study consisting of: (1) a literature review of development issues relating to ethnic minorities in the Central Highlands; (2) interviews with 14 leaders and 79 members of seven ethnic minority communities in Dak Lak and Gia Lai provinces; and (3) a survey among 54 staff and seven managers of five research and extension institutes in the Central Highlands and one in Hanoi.

ACTIVE PROJECTS

The information obtained from these activities primarily served as background material and reality check during a training workshop on 'Planning Research and Development Targeted at Ethnic Minorities' for 25 research and extension practitioners, which aimed at preparing them for future collaboration in a planned follow-up project in the Central Highlands applying participatory approaches.

The field interviews of the study did not intend to collect a statistically reliable set of data in these communities, but rather to provide an opportunity for project partners to learn from firsthand experience what the issues are and how they are perceived by the local people themselves. Despite the fact that selected communes were not amongst the remotest in the provinces and community members participating in the interviews were invited by the commune leaders (probably implying a biased sample selection towards the relatively better off) the results show some important trends.

With regard to education and languages issues, it was found that just over one-third of the respondents feel comfortable communicating in Vietnamese, notwithstanding the fact that the large majority attained several years of formal education. Interestingly, commune leaders tend to assess their people as being more proficient in Vietnamese than they do themselves. About half of the commune leaders use Vietnamese in their communications to the community, as a result of which community members complain that language is one of the constraints in dealing with the government, in addition to long distances and difficulties of getting access to government officials.

With regard to farmers' information access, a large majority of respondents in the communities in Gia Lai and Dak Lak (78% and 69%, respectively) expressed a need for information on agricultural topics. They particularly want to know about fertilisation and pest management practices and where they can purchase inputs for a reasonable price, which shows they know about input intensive technologies, but have not received adequate training or information.

Most farmers reported that they have never or seldom met an extension officer and their main sources of information are their fellow farmers or the agricultural input retailers. Extension officers interviewed expressed a concern about the knowledge of ethnic minority farmers relating to aspects of marketing, as a result of which they often sell their products for too low a price.

When asked about their preferred communication medium, a similarly large majority of respondents mentioned television, which they say is for mere entertainment since most of the programs aired are in Vietnamese language that they claim to have difficulty with. Local language programs, mainly local news, are broadcast only three times a week for 15 minutes in each of the major ethnic minority languages. As a means to improve communication within the local area, 62 and 83% of respondents in Gia Lai and Dak Lak, respectively, suggested establishing community radio facilities broadcasting in local languages.

The survey among research and extension staff revealed that a minority of both Hanoi and Central Highlands based researchers have had little exposure to training (30%) or field work (21%) applying a participatory approach, while almost all their colleagues at the university (80%) seemed to have had more opportunities. A fair proportion of the extension staff (especially in Gia Lai province) claims to have learned about participation but generally does not apply it.

The main constraints to implementation of participatory approaches mentioned are budget constraints, language barriers, infrastructure constraints (roads, training facilities), and low awareness and 'unfavourable attitude of farmers towards innovation'. The last aspect casts some doubts on the understanding some of the respondents may have with regard to participatory approaches.

ACTIVE PROJECTS

The training workshop engaged 25 staff from PPRI, WASI, ASISOV, Tay Nguyen University and the Plant Protection Sub-Departments and Agricultural Extension Stations in Dak Lak and Gia Lai provinces in learning exercises, discussions and field work related to rural development, ethnic minorities, participation, indigenous knowledge systems, targeted extension development, Objective Oriented Program Planning, and grant proposal development.

Participants expressed high levels of satisfaction and learning achievements with the training workshop, and strong commitment to future collaboration. The workshop resulted in a framework for a follow-up project with the overall goal tentatively formulated as 'Increasing income of ethnic minority farmers through improved soil health and land management capacity in marginal agroecosystem systems in the Central Highlands of Vietnam'.

CP/2006/113: Scoping study to review the role of women and assess constraints in the production of indigenous Vietnamese vegetables

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	NSW Department of Primary Industries, Gosford Horticultural Institute, Australia
Project Leader	Ms Virginia Brunton Phone: 02 4348 1913 Fax: 02 4348 1910 Email: virginia.brunton@dpi.nsw.gov.au
Collaborating Institutions	Vietnam Women's Union, International Cooperation's Department, Vietnam
Project Budget	\$86,744
Project Duration	01/02/2007 to 30/09/2007
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Until now little research and development has focused on the significant role of women in Vietnam's traditional, particularly indigenous, vegetable industry. This scoping study will start the development of a project that explores ways to alleviate rural and peri-urban poverty and enhance the role of women in the safe production, promotion, and utilisation of indigenous vegetables.

The study will collate and review information on R&D projects conducted on indigenous vegetables in Vietnam; review the role of women in the production, promotion and utilisation of indigenous vegetables; identify the indigenous vegetables with best potential for further industry development, and list the major constraints to enhancing their production, marketing and utilisation.

Project Progress & Outcomes

Year 1 (01/02/2007–30/09/2007)

It is anticipated that this scoping study will lead to a larger, 4-year project titled 'Increasing the skills of women in the safe production, promotion and utilisation of indigenous vegetables in Vietnam', to be led by NSW DPI. This project will also lead to improved farming practices and production information on new vegetables for farmers in Australia.

One important component of this study was the 2-day workshop. It began on Monday 7th May, and had the following objectives:

1. to review information on R&D projects conducted on indigenous vegetables in Vietnam
2. to identify the indigenous vegetables with greatest potential for further industry development
3. to identify collaborators to develop a full 4-year project designed to overcome major constraints to the further production, promotion and utilisation of indigenous vegetables by women.

The first day and a half was taken up with formal presentations and discussion. Close to 80 people and 20 media personnel attended. The participants included Heads and senior staff and scientists of the Vietnamese Women's Union (VWU); National Institute of Medicinal Materials (NIMM); Ministry of Planning and Investment; Food Crop Research Institute (FCRI); CASRAD, FAVRI; Fruit and Vegetable Research Institute (FAVRI); Hue Agriculture and Forestry University (HAFU); Nong Lam University HCMC; International Centre for Under Utilised Crops (ICUC); Asian Vegetable Research Institute; CIRAD; AusAID; Institute of Agriculture Science, HCMC; Xuan Son National Park; Saigon Co-op Mart; Vic DPI; NSW DPI; Sydney University; ACIAR ; Australia's ABC and local Vietnamese media and press.

The last session of the workshop attempted to finalise a shortlist of indigenous vegetables. However after an hour of discussion, in which delegates spoke on behalf of their particular preferences, no consensus could be reached. To finalise the list, a vote was organised and each delegate wrote a list of six plants they thought should be prioritised in the final project.

The final half day of the workshop was taken up with field visits. Participants toured the NIMM field site, where they saw a large range of vegetables and herbs with reputed medicinal values. They were also growing larger-scale field trials of angelica and wormwood.

Participants also visited Tan Minh commune – Thuong Tin district outside Hanoi, which is well known for its range of indigenous vegetables and herbs.

CP/2007/187: Technical support facility for commercialisation of protein bait production in north Vietnam

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Markets, Development and Investment, Vietnam
Project Leader	Dr Dominic Smith Phone: 84 4 7150498 Fax: 84 4 7150499 Email: dominic@mdivietnam.com
Collaborating Institutions	Griffith University, Australia Plant Protection Research Institute, Vietnam
Project Budget	\$120,000
Project Duration	01/02/2007 to 30/04/2008
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Vietnam's system of agricultural research funding has recently moved from a centrally planned system to one where institutions bid for research money out of core-funding. But in the next three years, research institutes must become almost entirely self-funded or face closure. They are therefore moving to commercialise research results and generate income.

This small research activity is supporting the pilot research commercialisation of a new company – a joint-venture of the Plant Protection Research Institute, Hoa Binh Pesticide Company and An Think Brewery.

The activity focuses on building a viable and sustainable market for the commercialised product – a fruitfly protein bait. A second part of the activity is to apply the lessons learnt from this pilot commercialisation for commercialising pro-poor research results in Vietnam's agricultural area.

Project Progress

Year 1 (01/02/2007–31/01/2008)

First progress report due in 2008.

CP/2007/211: Scoping study to identify research and implementation issues related to management of the Brown Planthopper/virus problem in rice in Vietnam

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	International Rice Research Institute, Philippines
Project Leader	Dr Kung Luen Heong Phone: 632 580 5600 ext 2726/home 2390 Fax: 632 580 5699 Email: k.heong@cgiar.org
Collaborating Institutions	Cu Long Rice Research Institute, Vietnam Ministry of Agriculture and Rural Development, Vietnam Food Crops Research Institute, Vietnam
Project Budget	\$110,000
Project Duration	01/05/2007 to 31/01/2008
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

In 2005–06 rice production in Vietnam, particularly in the Mekong Delta, suffered a major setback when outbreaks of brown planthopper (BPH) caused a loss of ~400,000 tonnes (1.1% of national production). The BPH infestation threatened rice exports and also prompted farmers to spray insecticides indiscriminately and excessively in attempts to curb the spread of viral infections transmitted by BPH.

This small research activity will focus on helping the Ministry of Agriculture and Rural Development of Vietnam to identify research and implementation issues related to management of the BPH/virus problem. Researchers will investigate the biology of the viruses, vector-virus relationships, vector migrations, vector ecology and farmers' perceptions of the vector and viral diseases, and apply the knowledge gained to develop an integrated management strategy for the BPH/virus problems.

Project Progress

Year 1 (01/05/2007–31/01/2008)

First progress report due in 2008.

FST/2001/021: Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying

Bilateral

Overseas Collaborating Countries	China, Vietnam
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Dr Russell Washusen Phone: 03 9545 2173 Email: russell.washusen@ensisjv.com
Collaborating Institutions	Forest Science Institute of Vietnam, Vietnam China Eucalypt Research Centre, China
Project Budget	\$519,932
Project Duration	01/07/2005 to 30/06/2009
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Traditional wood processing industries have utilised native forests for timber. As a result the industries in China and Vietnam, as elsewhere, have evolved processes for wood sawing that match the timber's used. Increasing demand for timber has placed the burden of production on native forests, many of which are now in decline. Harvest restrictions are now being applied in China and Vietnam, limiting timber production from native forests. With these restrictions have come pressures on employment and a greater reliance on timber importation, creating trade imbalances.

A solution is planting eucalypts, together with other species as part of reforestation programs. Eucalypts primarily supply raw material for large industries: pulp and paper, fibreboard and chipping. Small-scale use in traditional industries is also undertaken, such as for furniture and joinery. Mainly small diameter logs (less than 30 cm) are used, but growth stresses are released when these are sawn using traditional approaches, splitting the logs and rending them useless. Such constraints, plus the tendency of plantation-grown eucalypt wood to distort, have discouraged use.

The project aims to:

- improve the efficiency of processing of small diameter plantation grown eucalypt logs for solid wood products
- increase returns to plantation growers and
- assist in the development of viable rural industries in China, Vietnam and Australia.

Project Progress

Year 2 (01/07/2006–30/06/2007)

Project FST/2001/021 continued to develop joint activities with FST/1999/091 by conducting processing trials using that project's plantation material assessed in the field. This also involved engagement of industry in China, Vietnam and Australia. Major contributors were N. F. McDonnell & Sons (Victoria), Forest Enterprises Australia, the Dongmen veneer factory (China), Pisico (Vietnam), Raute (Singapore) and Veisto Oy (Finland). During the reporting period preparations were made for three processing trials (one each in China, Vietnam and Australia) and three others (one in China and two in Australia) either commenced or concluded.

A report on the first of the processing trials has been completed. This was a sawing trial with ~135 logs conducted in collaboration with Forests NSW and N.F. McDonnell & Sons in Victoria using four provenances of *E. nitens* (17 y old plantations located near Tumut NSW) with measured peripheral growth strain levels, acoustic wave velocity (AWV) and Pilodyn measurements.

The aim was to assess the capacity for these measurements to predict log and sawn board behaviour during harvest log handling and sawing. Sawing was conducted with a HewSaw R250. This machine is a single pass sawing machine developed by the Viesto Group in Finland that applies chippers and saws more-or-less simultaneously.

The chippers which profile the cants appear to remove sufficient high stressed wood to allow sawing to proceed with little difficulty. The major findings from this research was that growth strain was only moderately useful in predicting growth stress related log and board behaviour, AWV was found to be a good predictor of log and board end splitting and could be used to predict recovery of sawn boards after docking end splits. Bow in sawn boards was the only important board behaviour characteristic related to growth stress release during sawing.

Generally, this was of limited extent and not sufficiently severe to prevent major problems during transport and stacking of the boards. There was some provenance variation detected in log and board end-splitting and bow in sawn boards, suggesting some potential improvement in performance.

A second report has been prepared for a trial conducted at the Dongmen Forest Farm, Guangxi Province, China. This trial was a departure from proposed work because adequate sawing equipment could not be located in this region of China. To overcome this difficulty logs were peeled and peeled veneer sheets kiln dried using standard processing methods for the production of internal grade veneer at the veneer factory in Dongmen.

The trial used ~160 logs from a single clone of 12 y old *Eucalyptus urophylla* x *grandis* from a spacing trial located in the Dongmen Forest Farm testing six spacing treatments. Growth strain, AWV and a number of other standing tree measurements were assessed for their potential to predict veneer recovery and quality.

The main findings were that growth strain was a moderate predictor of log end splitting. On this occasion AWV was not a significant predictor of log end splitting. There was a significant effect detected for spacing treatment on recovery and value of veneer that was related to diameter growth. Models were developed that could predict recovery and product value based on log external features that could be used to value logs.

Simulations suggest that there are likely to be substantial improvements in product quality with pruning as branch related defects were clearly the major grade limiting factor. Even greater improvement in product quality and value may be achieved with the production of appearance grade veneer.

In addition to pruning trees a number of changes to processing methods would be required such as the application of pre-heating of logs, conveyors to transport veneer and veneer restraint in driers to prevent buckling and splitting of veneer. Log end splitting may also need to be reduced if appearance grade veneer was produced, but this was not specifically tested in this research.

A third trial conducted with the Hewsaw R200 at the FEA sawmill in Tasmania with ~480 logs from a Forests NSW *E. pilularis* family trial (10 y old plantations located near Port Macquarie, NSW) has been completed. A subset of ~160 logs was intensively measured to examine log and board behaviour as for the *E. nitens* trial above so that comparisons can be made between trials.

Product quality and value, board shrinkage and major grade limiting defects have been recorded for all logs. Financial modelling of the processing will be conducted using the financial analysis methodology in CSIRO MILL using a module developed specifically for the HewSaw R200. Veisto Oy in Finland has been engaged to assist with input data to develop this module of CSIRO MILL.

A processing trial is currently being planned for thinned 11 y old *E. urophylla* from a family trial at Ba Vi in northern Vietnam. This will be conducted at the Pisico sawmill at Quy Nhon in central Vietnam. Sawing will be undertaken with a horizontal band saw followed by application of sheltered air drying, steam reconditioning and kiln drying.

ACTIVE PROJECTS

This trial will apply standard sawing patterns for teak and a modified cutting pattern to assess the potential to reduce board end splitting. This project will also be conducted jointly with a project funded by MARD to compare a number of drying strategies for *E. urophylla* from central Vietnam. As with the completed processing trials, growth strain and AWV from standing trees or logs will also be assessed for their potential to predict log and board behavioural characteristics with growth stress release.

Assessment of the SilviScan technology in application for improvement in eucalypt resources for solid wood processing end uses has also been completed and a report prepared.

FST/2002/112: Domestication of Meliaceae species in Southeast Asia and Australia, particularly management of the problem of *Hypsipyla robusta* attack

Bilateral

Overseas Collaborating Countries	Laos, Thailand, Vietnam
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Mr Khongsak Pinyopusarek Phone: 02 6281 8247 Email: khongsak.pinyopusarek@csiro.au
Collaborating Institutions	Queensland Department of Primary Industries and Fisheries, Australia National University of Laos, Laos Department of National Parks, Wildlife and Plant Conservation, Thailand Forest Science Institute of Vietnam, Vietnam
Project Budget	\$386,083
Project Duration	01/07/2005 to 30/06/2008
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Many species of the Family Meliaceae native to Southeast Asia and Australia, including mahogany, *Chukrasia* and *Toona ciliata* (red cedar), produce high-value wood. Forest scientists have identified wild species suitable for domestication, but a barrier to plantation development has been their susceptibility to attacks by insects of the *Hypsipyla* genus. The larvae of these tip moths attack the stem apex, causing deformation that lowers the quality of harvested logs.

Previous ACIAR-supported research has advanced domestication prospects and identified *Hypsipyla*-resistant families and provenances. This project seeks to further test tolerant red cedar and *Chukrasia*, and to develop silvicultural and management protocols aimed at mitigating attacks. The research team is also undertaking capacity-building at partner-country research institutions.

The research objectives of this project are: to identify, develop and test tolerant genotypes of *Chukrasia* species and *Toona ciliata*; to establish silvicultural and management protocols mitigating *Hypsipyla robusta* damage; to undertake capacity building, communication and dissemination of project results.

Project Progress

Year 2 (01/07/2006–30/06/2007)

Vietnam

Two adjoining clonal trials of *Chukrasia* were established at Cam Qui (Ba Vi) on the same site that the provenance was established under ACIAR Project FST1996/005. Both trials contain the same genetic material.

However, one trial does not have any tree canopy while the second trial was initially planted with *A. mangium* hybrid then several months later planted with *Chukrasia*. The Ba Vi nursery carried out a decapitation trial of 30 clones across the three categories of recovery from hypsipyla attack. The results of this trial showed no difference between *chukrasia*'s ability to recover. They all produced a clear single leader.

The Ba Vi nursery has been preparing cuttings of selected clones of *chukrasia* for shipment to Thailand in order to complement the clones in that country.

ACTIVE PROJECTS

Thailand

A *Chukrasia* companion trial was established in May 2007 under an *Acacia mangium* planting in May 2006. The trial will look at the effects of *Hypsipyla* attack on *Chukrasia* grown under/companion to *A. mangium*.

Grafting was undertaken to establish a hedge garden representing 20 selected trees from the *Chukrasia* field trials at Kanchanaburi nursery. Scientists have commenced taking cuttings from the hedge garden. Additional plant material is being sourced from Vietnam selections.

Laos

The *Chukrasia* trial at the Agroforestry Research Station at Thongkhang, Luang Prabang was weeded during the course of the year. A one-week training course in trial design, establishment and analysis was undertaken at Luang Prabang in October 2006.

FST/2003/002: Development and evaluation of sterile triploids and polyploid breeding methodologies for commercial species of *Acacia* in Vietnam, South Africa and Australia

Bilateral

Overseas Collaborating Countries	South Africa, Vietnam
Commissioned Organisation	University of Tasmania, CRC for Sustainable Production Forestry, Australia
Project Leader	Professor Rod Griffin Phone: 03 6226 7946 Email: rod.griffin@ffp.csiro.au
Collaborating Institutions	CSIRO Forestry and Forest Products, Australia Forest Science Institute of Vietnam, Vietnam CSIR Environmentek, South Africa Sylvatech Ltd, Australia University of Adelaide, Australia
Project Budget	\$506,054
Project Duration	01/01/2004 to 30/06/2009 (Project extended from 01/07/2008 to 30/06/2009)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Several species of Australian *Acacia* have become commercially important in both tropical and temperate regions. These species have gained widespread acceptance due to their high yields, simple silvicultural regimes, prolific seed production and fast growth rates. These traits, however, also carry a level of risk when introduced into exotic environments, that species will reproduce and spread beyond plantations or planned growth to become invasive weeds.

The planting of sterile, but high-yielding varieties would overcome this risk. Some forms of acacias are sterile, offering protection against becoming invasive weeds in exotic environments. The sterility comes from manipulating chromosome numbers (ploidy) in search of improved productivity.

Some forms of polyploid such as triploids formed by mating diploid (2n) and tetraploid (4n) parents, are reproductively sterile which confers possible advantages in tree improvement: more harvestable woody biomass may be produced if energy is not invested in maturing fruits and seeds. When genetic modification technology is developed in the future the availability of sterile genotypes is expected to overcome concern about 'genetic pollution' through uncontrolled outcrossing to non-crop trees.

During 2001 Shell International Renewables Ltd donated tetraploid *Acacia mangium* (Am) plants to the Forest Science Institute of Vietnam and made available associated technical reports to the Australian partners. This offers potential to grow this species as a sterile but high-yielding variety.

The project is developing and assessing the utility of polyploid breeding methods for commercially important *Acacia* species, to position for production of triploid plants from elite germplasm for operational deployment. This goal will be achieved via activities within six sub-projects, each involving work by partner organisations in two or more countries.

Project Progress

Year 3 (01/01/2006–31/12/2006)

Due to the complex nature of the expression of ploidy after induction it has been necessary to devise a suite of protocols to efficiently (time and cost) and correctly identify the ploidy of an induced plant. This includes flow cytometry and stomatal size and density measurements. Near Infra Red (NIR) Spectrometry has now been added to the suite of tools. NIR is essential in identifying an induced plant as stable tetraploid, mixoploid or chimeric.

Once identified if the plant is coppiced then all coppice material must subsequently be retested and ploidy established. Using NIR we will scale up induction experiments in 2007–08 as ploidy identification is now cheaper and quicker. Stem material from 4N and 2N glasshouse plants were pulped with 4N fibres 15% longer than 2N. Fibre measurements will be repeated on Ba Vi field material in 2007–08.

Project scientists from CSIR visited UTAS for discussions on experimental procedures for CSIR. CSIR has applied colchicine induction treatments to both clonal and improved seed material. Growth after both seed treatment and treatment of buds on potted clonal material has been poor. This is not unexpected or unusual and is an observed response in many plant species.

A single tetraploid line of CSIR germplasm was sent back to CSIR by Shell Forestry to be propagated. This was undertaken by commercial nurseries but was unsuccessful. The mother plants at each nursery were tested for ploidy using both flow cytometry and stomatal analysis. Only one plant was verified as possible 4N with the remainder either reverted to 2N or mislabelled in the nursery. It will be used to investigate other tools for polyploid screening.

Verification of both ploidy and fingerprinting of Shell 4N clones in Vietnam has continued into 2007. Stomatal assays were prepared by RCFTI in Vietnam and assessed at UTAS on selected trees at two field sites. Trees were selected for testing if they had been used as CP mothers, sources of OP seed or selected for wood sampling. Fingerprinting at RCFTI to confirm clone identity has been unsuccessful, possibly due to type of equipment used. A project scientist from Vietnam, awarded a John Allwright Fellowship for study at UTAS, will continue this work as part of his Masters research beginning in July 2008.

Three field trials of polyploids interplanted with diploid *A. mangium* and *A. auriculiformis* were established in 2002–03 by RCFTI. The southern most trial had limited flowering in December 2005 and open pollinated seedlots from 13 trees were harvested. Ploidy of progeny was assessed using flow cytometry at UTAS, two clones had 4N progeny and nine clones had 2N progeny, two clones had few seed that did not germinate. No open pollinated triploids were found, but in this instance flowering was limited in the orchard and selfing is probable.

The 4N progeny are stable and will be planted out as soon as possible in Vietnam for selection. A scientist from UTAS was present during flowering in December 2006 to implement controlled pollinations and collect 4N flowers and pollen for monitoring of polyploid pollen viability and flower/pollen size variations. Detailed microscopic examination of flower morphology will be essential to establish whether biological barriers to inter-ploidy crossing exist. Field visits by the Project Leader in March 2007 also identified management/thinning regimes to be implemented.

No OP triploid seed has yet been identified from the polyploid field trials but testing will continue into 2007 following the harvest from December 2006 flowering. Additional work is planned to investigate the apparent reproductive barriers to production of triploids.

SMCN/2002/073: Efficient nutrient use in rice production in Vietnam achieved using inoculant biofertilisers

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	University of Sydney, Faculty of Agriculture, Australia
Project Leader	Professor Ivan R. Kennedy Phone: 02 93513546 Email: i.kennedy@acss.usyd.edu.au
Collaborating Institutions	CRC for Sustainable Rice Production, Australia Hanoi College of Science, Vietnam Institute of Agricultural Sciences of Southern Vietnam, Vietnam Can Tho University, Vietnam Soils and Fertilisers Institute, Vietnam
Project Budget	\$439,619
Project Duration	01/07/2004 to 31/12/2007 (Project extended from 01/07/2007 to 31/12/2007)
ACIAR Research Program Manager	Dr Gamini Keerthisinghe

Project background and objectives

Plant growth promoting rhizobacteria (PGPR) can exist naturally in soils and can be introduced through a process of inoculation. PGPR can improve plant growth and maximise grain yields, particularly where interactions with a group of cooperative factors including stimulated root growth, biological nitrogen fixation, mobilisation of soil N and P, facilitated uptake of nutrients and biocontrol of pathogens are optimised.

ACIAR-supported research introduced the concept of biofertiliser technology, through PGPR to parts of Vietnam. A key outcome of this concluded project was to prove the validity of using biofertilisers, both to researchers and particularly to farmers, who reported yield boosts in rice of between 10 and 20 per cent. In addition biofertilisers reduced input costs through lower use of urea. Despite this success the underlying mechanism responsible for the PGPR effect is not well understood.

Without this understanding expanding use of the "BioGro" biofertiliser beyond the original group of farmers in Vietnam's north is likely to prove difficult. The microbial composition of BioGro contained three different microbes, but in the future actual species used for this biofertiliser may vary. This could result in less than consistent responses and also make quality control based on a more thorough understanding difficult.

As the BioGro is tested beyond the north of Vietnam it is possible that different interactions may result in yield variations, a process that is dependent on the PGPR mechanism.

This project aims to establish inoculant biofertilisers for rice as a reliable technology and to foster extension of its application by studying its economic, social, and environmental benefits.

Project Progress

Year 3 (01/07/2006–30/06/2007)

In its third year, a major development in this project was the extension of this project to farmer trials of biofertiliser technology in the Mekong Delta region of Vietnam. Cantho University's Mekong Delta Development Research Institute held a project workshop in September 2006 focusing on this development.

At the commencement of the ACIAR project, the MDI's Director Dr Tran Thanh Be had discussed the following features of the Mekong Delta: (i) variation in soil types from acid sulfate soils (low pH, 4–6), alluvial soils and grey soils; (ii) the different style of rice farming in the south, with farm sizes on average about 2 ha, broadcast sowing of rice, and features such as the use of the leaf colour chart used to indicate N-status of rice crops; and (iii) work would be carried out developing a suitable production function to optimise economic production of rice with substitution of chemical fertilisers with BioGro.

Since there was currently a strong government-sponsored extension program in the Mekong region promoting the concept of 'less seed, pesticide and fertiliser for more yield, quality and income' (that is '3 giam, 3 tang' in Vietnamese, i.e. '3 reductions, 3 gains'), the use of BioGro for efficient nutrient utilisation at this stage was highly consistent with this goal.

The highlight of the workshop was the presentation by Dr Be reporting the results of a set of BioGro farmer field trials in three regions, acidic saline (normally two crops per year, Long Phu, Soc Trang), alluvial (three crops per year, Tra On, Vinh Long) and flood-prone (two crops per year, Cho Moi, An Giang). BioGro (300 kg/ha) provided by Professor Hien in Hanoi was applied by mixing with rice seed, which was broadcast into flooded paddies.

Net costs, benefit-cost ratios and production costs were presented for all sites and cropping seasons. Advantages of BioGro were identified as decreased urea N-inputs, stronger stems and less lodging, less pests, cleaner grains and less environmental pollution. Disadvantages were noted as prevalence of golden snail in wetter conditions maintained (unnecessarily) with BioGro, inconvenient weight, inability to mix with pesticides or fertiliser, difficulty to apply by dry seeding and, most importantly, the unavailability of BioGro in the Mekong Delta because of the lack of local production.

The field trials of BioGro conducted in both dry and wet seasons in the An Giang, Vinh Long and Soc Trang planned by Dr Tran Thanh Be's team at the MDI have shown clear economic benefits to farmers exceeding 1 million VND per hectare compared to normal farmer practice regarding chemical fertiliser use. This was the result of being able to lower their fertiliser inputs to half and while achieving the same or increased yields of rice.

Farmers reported improved quality of rice with brighter grain, reduced lodging and less need for chemical pest control as well as more efficient use of the nutrient N, P and K. Mr Nguyen Thanh Tam, reported these results to the Biennial Conference for Young Researchers in Science and Technology for Agriculture, Forestry and Aquaculture held in Hue.

The reasons for such success in applying BioGro can now be better understood as a result of field experiments conducted by IAS in Ho Chi Minh City. Carefully replicated experiments in both the dry and the rainy seasons at Tay Ninh east of Ho Chi Minh City showed that applying BioGro allowed the same or increased yields of rice with much lower inputs of urea-N or fused magnesium phosphate-P.

Supplementary experiments including the use of nitrogen-15 conducted in the IAS laboratories assisted by Australian Youth Ambassador for Development Dr Michael Rose have verified the ability of the microbial strains in BioGro to improve transfer of N and P to rice plants. Antibodies prepared to biofertiliser strains for use in quality control tests for BioGro were also returned to the University of Sydney for further use in the project's research.

Research continued in Australia on the feasibility of applying immunoblotting as a rapid means of identifying and counting biofertiliser strains. Unfortunately, a new field trial to follow up previous results obtained at the Australian Rice Research Institute at Jerilderie could not be conducted because of the continuing drought.

CP/2001/027: Adaptation of low-chill temperate fruits to Australia, Thailand, Laos and Vietnam

Bilateral

Overseas Collaborating Countries	Laos, Thailand, Vietnam
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Maroochy Horticultural Research Station, Australia
Project Leader	Dr Alan George Phone: 07 5441 2211 Fax: 07 5430 4994 Email: alan.george@dpi.qld.gov.au
Collaborating Institutions	Fruits and Vegetables Research Institute Plant Protection Institute National Agriculture and Forestry Research Institute, Laos Southern Fruit Research Institute, Vietnam Department of Agriculture, Thailand
Project Budget	\$687,393
Project Duration	01/07/2001 to 30/06/2007 (Project extended from 01/07/2004 to 30/06/2007)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

This project extends previous research investigating the development of a sustainable temperate fruit industry in Thailand. Temperate fruit industries in Thailand are in the early stages of development, but high prices are paid for temperate fruits in Thai domestic markets. The production of high-value temperate fruits would raise living standards of hill tribe people and encourage them to use sustainable cropping systems. There is also an export market window into other Asian countries from March to May.

Vietnam already grows many fruit crops and the average revenue from fruit production is two to three times higher than that of rice. It is estimated that many more areas are suitable for temperate fruit production. Laos only grows poor-quality local varieties but has other suitable areas to grow low-chill temperate fruit. The problems for growing temperate fruits in Vietnam and Laos are similar to those that have been identified in Thailand: development of insect pests and diseases during high humidity, lack of knowledge on how to select the best varieties and manage the crops, lack of nurseries, and lack of marketing studies or plans.

The project aims to establish and develop sustainable low-chill temperate fruit industries (stone, pomegranate fruit and persimmon) in Thailand, Laos and Vietnam through the identification of appropriate sites and varieties and through the implementation of best management practices at the farm level.

Project Outcomes

The overall objective of the project was to develop sustainable temperate fruit industries in Thailand and Lao PDR. Because of the excellent market opportunities for stonefruit and persimmon in Asia, the project focused on introducing new varieties of these species and adapting advanced technologies developed in Australia for Thai and Lao farmers.

The second extension of the project has demonstrated that with new varieties and management systems that high returns can be achieved from temperate fruits in warm subtropical regions of Asia. For example, in Lao PDR, farmers achieved incomes of about \$A6000–8000 per hectare from low-chill peach and nectarine production, about 20–30 times greater than their usual annual income of \$A300 from growing upland rice and corn.

CONCLUDED PROJECTS

At Ang Kang in northern Thailand, trees of peach cv. Tropic Beauty produced 120–150 fruit per tree with an estimated yield of 8–10 tonnes per hectare. Fruit quality was excellent with average fruit weights of 150 g and high sugar content. Using an average price of 80 baht per kg, we demonstrated that farmers could achieve gross returns of \$A25,000 per hectare even in very steep, marginal country.

In Lao PDR, the project successfully extended temperate fruit production systems to four new districts in Xiengkhouang Province and the nearby province of Huaphan. A small nursery, near the Regional Agricultural Office in Ponsavan, has been established to propagate temperate fruit and other subtropical fruit species. Due to the success of the project, the Lao Ministry of Agriculture is now actively promoting temperate fruit production in cooler regions of the country.

In Thailand, the Thai DOA has established stonefruit demonstration orchards at 20 farmer sites in Khun Wang, Ang Kang and Chiang Rai Provinces. Tree age varies from 3 to 5 years of age. Older trees have commenced cropping. Peach cv. Tropic Beauty has produced high quality fruit. For example, one farmer has achieved yields on 4-year-old peach trees of about 120 fruit (18–20 kg per tree). Because the quality of fruit was high, with about 30% of the fruit extra grade, this farmer received on average 80 baht/kg (\$A3 per kg).

Although the temperate fruit growing regions of both Thailand and Lao PDR have a plentiful supply of water, which is held in small dams, farmers lack expertise and funding in designing and installing suitable irrigation systems. In Lao PDR, the project successfully installed a minisprinkler irrigation system, the first of its type in this country, at one commercial farmer's orchard.

Extension, farmer training and communication channels

At the commencement of the project extension, an extension methodology workshop was held in Chiang Mai Thailand to examine ways of improving delivery of temperate fruit methodologies to farmers. As a consequence, an improved understanding on the best extension methodologies was developed.

Excellent communication links have now been established between Australian, Thai and Lao researcher and extension officers. Mr Pichit Sripinta, Thai DOA, conducts monthly visits to the World Vision Centre at Ban Kon village near Chiang Rai to train local farmers and World Vision extension officers in temperate fruit technologies. Since this training has commenced, there has been a significant improvement in the quality of stonefruit marketed from this region.

Thai DOA researchers are now transferring the technologies developed in this project to other Asian countries such as China through formalised projects. They are also continuing their training of Lao research and extension officers.

Marketing

In Thailand, sensory evaluation studies were conducted at both Royal Ang Kang and Khun Wang Research Stations. Our analyses showed that four of the newly introduced stonefruit varieties are well accepted by Thai consumers. Our studies showed that both Thai and Lao PDR consumers prefer large, highly coloured fruit with high sugar concentrations and low acid.

Conclusions

It will take at least a further 10 years for the new temperate fruit technologies to be transferred and successfully adopted by Thai and Lao farmers. The rate of adoption will be slow because farmers in these countries are unfamiliar with fruit tree technologies in general and because they associate a greater degree of financial risk with growing temperate fruits compared with short-term crops such as vegetables and corn. Additionally, extension officers need to become more confident in training farmers in these technologies. However, those farmers who have adopted the new technologies to date have reaped the financial rewards and this should provide the catalyst for further growth.

CP/2005/053: Plant disease diagnostic manual

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	University of Sydney, Australia
Project Leader	Professor Lester Burgess Phone: 02 93512526 Fax: 02 93516481 Email: l.burgess@agec.usyd.edu.au
Project Budget	\$30,000
Project Duration	01/05/2006 to 31/08/2007 (Project extended from 01/11/2006 to 31/08/2007)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

The manual will contain guidelines on methods most commonly used to diagnose plant diseases. Recommendation of effective control measures depend on proper identification of diseases and of the causal agents. Without proper identification of the disease and the disease-causing agent, disease control measures can be a waste of time and money and can lead to further plant losses. Plant diagnosis involves the analysis of plant material and soil for bacterial, fungal, viral, mycoplasma and nematode pathogens.

This includes correct identification of diseased plant and plant parts, sample collection, preservation, studying of visual symptoms on plants and presence or signs of biotic agents on affected plant parts, isolation techniques, sourcing published reference and illustrations, knowledge on equipment used in diagnosis, diagnostic laboratory tests for both biotic and abiotic causal agents, consideration of cultural and environmental conditions, documentation and reporting.

The manual covers the collation of disease information, illustrations and training notes used in disease diagnosis from the following concluded and active ACIAR projects notably: CS2/1994/965, CP/1999/007, CP/2002/115, CP/2000/094 and other crop protection projects dealing with plant diseases. The target audience for the manual comprises scientists, extension workers, researchers and students in plant pathology and agriculture.

Project Progress

Final report due in 2007.

FIS/2000/018: The economics of developing reservoir aquaculture in Vietnam

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	University of Western Australia, Faculty of Agriculture, Australia
Project Leader	Dr Steven Schilizzi Phone: 08 6488 2105 Fax: 08 6488 1098 Email: steven.schilizzi@uwa.edu.au
Collaborating Institutions	Nong Lam University, Ho Chi Minh City, Vietnam Research Institute for Aquaculture No. 1, Vietnam Institute of Fisheries Economics and Policy, Vietnam Deakin University, Australia
Project Budget	\$341,127
Project Duration	01/07/2002 to 31/07/2007 (Project extended from 01/07/2005 to 31/07/2007)
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Reviewers of the ACIAR-supported project 'Reservoir fishery development and management in the northern mid highland region, Vietnam' highlighted the urgent need to carry out socio-economic studies of reservoir fishery development in Vietnam. Although potential for poverty alleviation is high in the midland and upland regions, little attention has been paid to the economics of expanding production, and consequently hoped-for production targets are unlikely to be fulfilled.

This project is focusing on small-scale reservoirs (including coves and cages in larger reservoirs), which have a higher economic potential than stock enhancement of the large reservoirs.

Project researchers are seeking to address issues such as where to find markets for increased fish production in remote areas, how better farm management (like timing of stocking) can improve income, what fish species are economically suitable, and how property rights to water bodies are allocated and protected. Their answers are expected to give planners better insights into economic factors affecting returns to fisheries development; and help farmers/fishers to better manage their aquaculture systems.

Project Progress

Year 3 (01/07/2006–31/05/2007)

Annual report not yet submitted by the Commissioned Organisation.

FIS/2000/065: Assessing the potential for low cost formulated diets for mud crab aquaculture in Australia, Indonesia and Vietnam

Bilateral

Overseas Collaborating Countries	Indonesia, Vietnam
Commissioned Organisation	Queensland University of Technology, School of Natural Resource Sciences, Australia
Project Leader	Dr Peter Mather Email: p.mather@qut.edu.au
Collaborating Institutions	Gondol Research Institute for Mariculture, Indonesia Queensland Department of Primary Industries and Fisheries, Australia Research Institute for Aquaculture No. 3, Vietnam
Project Budget	\$390,521
Project Duration	01/07/2004 to 30/06/2008 (Project extended from 01/07/2006 to 30/06/2008)
ACIAR Research Program Manager	Dr Geoff Allan

Project background and objectives

Global demand for mud crabs has risen over the past decade, led by expanding wealthier markets such as those in Hong Kong, Singapore and elsewhere in Asia. This demand has largely been met by exploitation of wild stocks, causing many to go into decline. Current trends in these fisheries suggest this exploitation is unsustainable. This situation continues to be exacerbated by rising demand for seafood.

Mud crabs (*Scylla* species) are widely distributed across the Indo-Pacific region, mainly in coastal and estuarine areas, making them ideal for fishing. This does also make them highly suitable for aquaculture, providing some barriers to production can be overcome. Past ACIAR-supported research has developed laboratory-scale technologies for raising crabs from larvae, a first step in aquaculture development. Large-scale hatchery production is now under way in Vietnam where a leading centre for crab aquaculture has been established, along with others in Indonesia, the Philippines and Australia.

Until diets suitable for crab grow-out can be formulated, based on meeting their nutritional needs, further advances will be limited. Most aquaculture of crabs uses 'trash-fish' collected from marine inshore areas or mussel meat from intertidal areas. This can damage these environments and not all feed is likely to be consumed, fouling hatchery ponds.

Growing exploitation of trash fish is also leading to declining numbers, threatening the viability of aquaculture. A cost-effective replacement diet is needed to ensure the benefits gained to date are not lost.

Experimental diets formulated for use in mud crab aquaculture in the partner countries will be tested for their ability to promote growth under laboratory conditions. If successful, these diets will be used as a basis for developing artificial feeds optimised for mud crab aquaculture. This will require developing diets that are:

- cheaper than the current diets used in intensive or semi-intensive mud crab aquaculture (i.e. prawn feeds in Australia and trash fish in Indonesia and Vietnam)
- able to provide similar or superior production performance to currently available crustacean feeds
- less likely to impact on water quality than current mud crab diets
- based on food grade resources which can accommodate the projected growth of the mud crab industry in Australia and the partner countries (PCs)
- made without terrestrial animal protein sources that may transmit diseases such as BSE.

The aim of this project is to:

- evaluate potential for formulated feeds to replace trash fish
- determine critical nutritional requirements and evaluate key ingredients
- determine the protein/energy requirements of mud crabs during grow-out phases
- formulate and evaluate improved diets.

Project progress

Year 3 (01/07/2006–30/06/2007)

The current project represents an extension to ACIAR project FIS/2000/065 which aimed to identify the potential of terrestrial animal and plant-based feed meals for use in diets formulated for mud crabs cultured in Australia, Vietnam and Indonesia. The project was initiated in response to recognition that a major constraint to mud crab aquaculture is the lack of diets specifically formulated for cultured crabs.

Although artificial diets have been used for crab aquaculture, such diets have primarily been designed for prawn species and contain high levels of relatively expensive animal-based feed ingredients, such as fishmeal. A key aim of the original FIS/2000/065 project was therefore to identify low cost animal and plant-based feed ingredients with potential to replace marine animal-based protein in diets used for mud crab production in Indonesia, Vietnam and Australia.

The original project was conducted at Queensland University of Technology (QUT, Australia), Bribie Island Aquaculture Research Centre (BIARC, Qld, Australia), Gondol Research Institute for Mariculture (GRIM, Bali, Indonesia) and Research Institute for Aquaculture No. 3 (RIA3, Nha Trang, Vietnam). Research conducted at BIARC utilised the local mud crab species, *S. serrata* and was conducted in three separate studies.

In the first study, the optimum dietary protein and lipid requirements for juvenile crabs in intensive culture were investigated. The second study assessed the digestibility of high protein feed meals from a range of plant, single cell or terrestrial animal sources. A third study focused on the potential of poultry meal and soybean meal to replace fishmeal in diets formulated for juvenile mud crabs.

Research components conducted at GRIM (Indonesia) and RIA3 (Vietnam) replicated the studies conducted in Australia but utilised locally available feed ingredients and selected the local mud crab species, *S. paramamosian* for culture.

1. In June 2006, the major findings of the original FIS/2000/065 project were presented at a two day workshop at the Nha Trang Lodge in Nha Trang, Vietnam. The key findings presented at the workshop were: In intensive culture, maximum growth of *S. serrata* was achieved using a formulated diet containing 55% crude protein and 15% lipid. Growth performance obtained using this diet was equivalent to that obtained using a commercial shrimp diet.
2. In intensive culture, maximum growth of *S. paramamosian* was achieved using formulated diets containing 43–45% crude protein and 9–15% lipid.
3. A broad range of plant and animal-based feed meals were identified that were readily digested by mud crabs.
4. In some instances, up to 40% of fishmeal in formulated diets could be replaced by high protein animal or plant-based meals without significantly reducing growth performance.

During an ACIAR commissioned review of this project it was stated: 'Results in the main were encouraging and supported earlier findings that mud crabs can efficiently digest a wide range of relatively cheap and abundant plant, animal and single cell based ingredients.'

Significant problems matching experimental systems to 'real world' conditions, however, were encountered. In particular, the results of growth trials using individually reared crablets were confounded by relatively low growth rates (around 50% of those achieved in pond culture), raising concerns that some outcomes might differ when crabs are raised in ponds. In particular, it was observed that access to 'ad libitum' feeding in preliminary pond trials in Vietnam promoted higher growth rates than were achieved in experimental systems.

Since growth rates in the laboratory may be influenced by feeding practices, additional studies were recommended to optimise factors such as optimal feeding rates and frequencies. The current extension to project FIS/2000/065 represents an attempt to address the concerns raised by the review of the original two-year project and was initiated in late 2006 when ACIAR invited the Australian project partners (QUT and BIARC) to apply for a 12-month extension to the project.

The project aims to investigate why growth rates previously recorded in intensive cellular culture are significantly lower than those seen in pond systems. This aim is being addressed through the use of an improved culture system at BIARC with an automated feeding mechanism which permits a much broader range of feeding protocols to be tested than was possible in the original project. Once feeding protocols have been optimised, the next major aim will be to determine appropriate inclusion levels of protein and lipid in formulated diets.

Funding for the extension to project FIS/2000/065 was released to the Australian project partners in May–June 2007 and growth trials associated with the first study have recently commenced at BIARC.

FIS/2001/058: Sustainable tropical spiny lobster aquaculture in Vietnam and Australia

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	CSIRO Marine Research, Australia
Project Leader	Dr Kevin Williams Phone: 07 3826 7284 Fax: 07 3826 7222 Email: kevin.williams@csiro.au
Collaborating Institutions	Research Institute for Aquaculture No. 3, Vietnam Queensland Department of Primary Industries and Fisheries, Australia Institute of Oceanography, Vietnam University of Fisheries, Vietnam
Project Budget	\$862,080
Project Duration	01/01/2005 to 30/06/2008
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Marine lobsters attract premium prices, selling for an average of A\$50 per kilogram (Vietnam figures 2001–02), reflecting the high level of demand. Supply, however, has reached its maximum sustainable levels in many fisheries and in some cases has breached these levels. If increasing demand is to be met, it must be sustainably – aquaculture offering the only way of achieving this. In Vietnam the production of cultured lobster is estimated as being worth \$A100m a year.

An abundance of lobster seed is the main driving force behind the industry's recent expansion. But mortality rates in rearing lobster from seed remain high. Rearing is based on a diet of fresh fishery by-catch, which is seen as a source of increasing environmental pollution. Both wild collection of seed stock and the trawling and use of bycatch are threatening the industry's long-term sustainability, as coastal environments begin to degrade and pressure grows on lobster populations.

The Vietnamese grow-out industry has a low-technology base, predominately using sea cages to fatten the ornate tropical lobster (*Panulirus ornatus*). Improvements in post-capture survival rates when rearing, including through pellet diets that reduce environmental impacts, will substantially boost production, benefiting the industry in Vietnam and Australia.

The project is working to enhance the sustainable production of tropical spiny lobster in Vietnam (and indirectly more widely throughout Southeast Asia) and to develop technology that facilitates commercial establishment of tropical spiny lobster grow-out aquaculture in Australia.

Project Progress

Year 2 (01/01/2006–31/12/2006)

Ecological impact of lobster seed collection and seasonal incidence of breeding in caged lobsters in Vietnam

ION staff carried out a census of lobster seed collection along the central coast of Vietnam over the period of October 2005 to April 2006. This entailed a survey of 71 of the known 81 dealers and 33 of the 34 lobster farming villages in the eight central coastal provinces from Da Nang in the north to Binh Thuan in the south. Total recorded collection of *Panulirus ornatus* seed was 1,917,910 with the three central Provinces of Binh Dinh (453,450), Khanh Hoa (415,690) and Phu Yen (414,860) recording the highest numbers. It is thought that this census represented at least 90% of total Vietnamese *P. ornatus* seed collection.

A census for the 2006–07 settlement year has commenced with 86 dealers and 31 lobster farming villages providing data. Settlement numbers so far appear to be lower than last year with average catches of only two individuals per boat per night. The price of the seed this year has risen more than 10% and currently is 175–185 thousand Dong (\$A17–18) per individual. NTU staff surveyed the incidence of breeding in caged lobsters in four lobster farming villages in Khanh Hoa and Phu Yen Provinces in May–July and again August–December, 2006. Where males and females were caged together almost all females over 600–700 g were berried while only a few lobsters over 900 g were carrying eggs.

Farmers reported that most females with eggs after December would succumb to fungal infection of the egg mass, most likely due to deteriorating water quality at this time.

Reducing post-capture losses of seed lobsters

RIA3 staff carried out two experiments to examine the effects of stocking density, initial holding time, subsequent transport time and feed type on growth and survival of seed lobsters from time of catch through to 90 days of nursery culture. The results indicated that within the bounds of current commercial practices, stocking density and initial land-based holding time had only slight effects on subsequent growth and survival of the lobsters.

However, increasing transport time from 1 to 6 or 12 hours had a profound adverse effect on survival rate, which often was apparent only after 30 days of nursery culture. Examination of the effect of feeding either a formulated diet or trash fish during the nursery phase was confounded by low acceptance of the formulated diet by the lobsters. Improved transport methods are currently being compared to find better methods that reduce the stress on the lobsters during transport.

In a third experiment that is currently under way, four different 6-h transport conditions (static, normal aeration with or without shelter and compressed air without shelter) have resulted in 100% survival after transport. The effect these transport conditions have on lobster growth and survival during the nursery phase is under investigation.

Husbandry best-practices for lobster grow-out

Improved and less-polluting methods for seacage grow-out of lobsters: An experiment to see if culturing lobsters and mussels together improves lobster cage productivity and adjacent environmental conditions commenced in March 2006. Four cage sites in Nha Phu Bay (Khanh Hoa) and four cooperating lobster farmers from Xuan Tu village were chosen for the work.

At two of the sites, lobsters are being co-cultured with green mussels (*Perna viridis*) while at two of the sites, half of the cages on experiment are being fed only trash fish while the other half are additionally being fed with mussels. Lobster productivity (survival, growth, food allocation) is being monitored monthly with 6-monthly monitoring of water column, sediment and mussel and lobster tissue for chemical (including heavy metal) and microbiological status.

The experiment will continue for 18 months. After 8 months of culture, feeding either trash fish or trash fish plus mussel appears to have had no effect on survival or growth of the lobsters. Two of the sites are showing higher lobster growth rates but this appears to be unrelated to mussel co-culture.

Some site-specific environmental differences are being observed, both within and between sampling times (May and October 2006), but these cannot be attributed to the imposed experimental conditions. Effects of season, river inflow and other land and cage pollutants are thought to be having as great, if not greater, effect on the environmental conditions at the cage sites.

Heavy metal analysis of mussels and lobsters have recorded levels below the maximums set for seafood safety and while *Vibrio* and faecal coliform counts were high and universally present in water column, sediment and mussel tissue (*Vibrio* only), no pathogenic bacteria were found in any of the lobster samples.

Improving lobster grow-out feeds: In Vietnam, NTU is investigating ways of optimising the utilisation of trash fish, both to maximise growth and survival of the lobsters and also to reduce the environmental impact of this type of feeding.

In the first of two 8-week growth assay experiments, three different types of trash fish (lizard, bream or anchovy) and two vitamin supplementation levels (with or without vitamin premix) were examined factorially when made into moist feeds using transglutaminase (TG) binding methods. Initial statistical analysis of the results showed no significant treatment differences but strong trends for improved growth of vitamin-supplemented lobsters and those fed the lizard fish as the trash fish source.

In the second experiment, the effectiveness of three different binders – Magicoh (an urea-formaldehyde binder), TG and an undisclosed USA binder – were evaluated. Water stability of the semi-moist pellets was best for the TG-bound diets while lobster growth rate was significantly better for the Magicoh and TG-bound diets than the USA binder.

At CSIRO, work determining the apparent nutrient and energy digestibility of eight key dry feed ingredients – Chilean fish meal, Antarctic krill meal, NZ mussel meal, lango crustacean meal, Japanese squid meal, dehulled narrow-leaf lupin, solvent-extracted soybean meal and wheat – was completed. Apart from an unexpectedly low digestibility for the squid meal, the digestibility of all other test ingredients was similar to that observed with other decapod crustaceans.

The main focus of CSIRO research has been to determine the dietary cholesterol requirement of sub-adult (600–700 g) and juvenile (~0.5–3.5 g) lobsters. In a 6-week depletion and 16-week repletion cholesterol experiment, sub-adult lobsters were fed TG-moist feeds that in the repletion phase provided incremental amounts of cholesterol from 0.15 to 0.45% (DM basis).

Based on cholesterol content of the digestive gland, a dietary cholesterol level of 0.35% was sufficient for these lobsters when the diet also contained 1.5% phospholipid. However, caution needs to be exercised because of an unexplained poor growth of the lobsters in the experiment. A 1-week depletion and 9-week repletion cholesterol experiment with juvenile (~0.5–3.5 g) lobsters has just terminated (December 2006). Lobsters were fed the same formulations as used in the sub-adult study except that the TG-diets were fed three times daily (AM, PM and midnight).

Although the data analysis of the experiment is incomplete, the growth of the lobsters was excellent with the best growth (1 g/week) occurring on the 0.45% cholesterol diet and this appears to be better than lobsters fed a control diet of fresh mussel/fish/shrimp (0.8 g/week). The overall survival rate was 67% but this was markedly affected by the initial size of the lobsters, only 43% for lobsters <0.5 g and 90% for lobsters of >3 g. Survival rate was worst for the 0.15% cholesterol diet (52%) with all other diets having lobster survival rates ranging from 60 to 76%.

Land-based systems for lobster culture: More than 500 recently settled *P. ornatus* lobsters were collected from Trinity Inlet, Cairns by QDPIF staff in September and October 2006. This enabled research with juvenile lobsters to be carried out at the QDPIF's and CSIRO's laboratories. At QDPIF's Northern Fisheries Centre, a series of experiments was carried out to investigate different feeding schedules on growth and survival of the lobsters.

Feeding lobsters continuously during the night did not improve growth or survival of lobsters given single meals at dusk and again in the morning. The main food used in the experiment was a commercial kuruma (*Penaeus japonicus*) shrimp pellet and losses due to cannibalism were high, with survival rate averaging 62% after 1-month culture. Another experiment is examining the importance of timing of feeding and specifically testing whether it is better to provide a single meal of fresh mussel in the morning or at dusk, the latter more closely mimicking natural peak feeding activity.

FIS/2002/068: Improving feeds and feeding for small scale aquaculture in Vietnam and Cambodia

Bilateral

Overseas Collaborating Countries	Cambodia, Vietnam
Commissioned Organisation	Department of Fisheries, Western Australia, Fremantle Maritime Centre, Australia
Project Leader	Dr Brett Glencross Phone: 08 9239 8103 Fax: 08 9239 8105 Email: bglencross@fish.wa.gov.au
Collaborating Institutions	Can Tho University, Vietnam Royal University of Agriculture, Cambodia Lake Argyle Industries Pty Ltd, Australia Research Institute for Aquaculture No. 1, Vietnam Aquaservice, Vietnam
Project Budget	\$711,460
Project Duration	01/01/2004 to 31/12/2007 (Project extended from 01/07/2007 to 31/12/2007)
ACIAR Research Program Manager	Dr Geoff Allan

Project background and objectives

Aquaculture, or fish farming, is the fastest growing food production sector in the world. It is being seen as a sustainable solution to the growing pressure that increased fishing activities are placing on wild resources. Advances in culturing fish are reducing the capture of wild juvenile fish, to then grow to size, boosting the value of fish farming. But further advances are needed to ensure aquaculture itself remains a viable and sustainable option for smallholders and the environment alike.

One component where advances could enhance sustainability is in fish diets. Most fish farmers do not buy commercial feeds. The high costs of these feeds are not adequately returned in the market price of fish. Farmers make their own feeds using available ingredients, such as rice bran and trash fish. Often these formulations do not sufficiently meet the nutritional needs of growing juvenile fish. To compensate some farmers ensure excess food and nutrients are available, eating into profit margins and increasing the likelihood of environmental impacts.

In Vietnam and Cambodia smallholder farmers are keen to get involved in aquaculture. The main barrier is a lack of information on the ingredients for diets. This, when assessed against the nutritional needs of fish species farmed, can help in formulating optimal diets.

Differences in feed requirements also extend to the stage of development; high protein and energy required in juvenile fish is not always suitable for maintaining health in fully grown fish. Bio-energetic modelling, using these variables, can define protein and energy requirements and then guide the formulation of diets using local ingredients to match these parameters.

The overall aim of the project is to enhance the development of sustainable aquaculture using locally derived ingredients and better formulated feeds to:

- develop diets based on locally-available ingredients for improved production of (Pangasius catfish and tilapia in southern Vietnam, Pangasius catfish in northern Vietnam and Cambodia and barramundi in Australia),
- demonstrate/evaluate the potential of new improved feeds in on farm trials, and
- transfer technology and extend information.

Project Progress

Year 3 (01/01/2006–31/12/2006)

Develop diets based on locally available ingredients for improved production of catfish and tilapia

Further progress has been made in collecting a range of ingredient samples for a collective ingredient database for Vietnam and Cambodia. The data include the source history, diversity of species involved in some resources (e.g. trash-fish), price variability and nutritional composition. The digestible value to *Pangasius* catfish of eight key ingredients has been determined.

Nutritional requirements of fish species in Vietnam & Cambodia

Growth and temperature data, and samples of tilapia and catfish from commercial farms for development of fish growth models have been collected in both northern and southern Vietnam. Progress with collection of data and/or samples from Cambodia has been limited, but significantly improved after the location of Mr Daniel Wright from Australian Volunteers International (AVI) person with the group. Maintenance energetics trials on tilapia and catfish were successfully re-run in both northern and southern Vietnam. Sample and data analysis from these trials has also been completed. The energy utilisation efficiency trial was completed for catfish, but was not successful for tilapia. A functional factorial bio-energetic model for catfish has now been constructed and has been used to iteratively define nutritional protein and energy requirements for this species. Tilapia model remains to be constructed pending re-evaluation of data limitations.

Nutritional requirements of barramundi in Australia

All growth model studies have been completed and the existing growth and metabolic models developed by Dr Glencross are presently being further refined based on the higher temperature data derived from earlier experiments as new knowledge is gained. Two additional studies have been undertaken, one to validate some outputs of the model and another to examine the nutritional potential of alleviating heat stress in fish.

Diet formulation for catfish, tilapia and barramundi

Iterative diet designs have been derived from the catfish and barramundi models. This has led to the formulation of a series of diets based on the ingredient assessment work and these revised diet specifications. These diets are presently being tested with catfish. Based on outcomes from the barramundi model the use of high-energy diets for large barramundi has been examined and shown to provide a significant advantage to production efficiency.

Demonstrate/evaluate the potential of new improved feeds in on-farm trials

Diets based on the ingredient evaluation and nutritional modelling of protein and energy demands of catfish are presently being tested in laboratory at Can Tho University. This work will be extended to farms and feed mills pending the outcome of the work. Further follow up assessment is required to review the outcomes of this validation trial.

Transfer technology and extend information

A four-day Aquaculture Nutrition Masterclass Shortcourse was held at Can Tho University College of Aquaculture and Fisheries in March 2007. This Shortcourse focused on dissemination of general aquaculture nutrition science and project findings to researchers, farmers and feed manufacturers from southern Vietnam and Cambodia. Course content also included field visits to fish farms, feed mills, laboratories and practical formulation classes.

FIS/2002/077: Improved hatchery and growout technology for marine finfish in the Asia-Pacific region

Bilateral

Overseas Collaborating Countries	Indonesia, Philippines, Thailand, Vietnam
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Agency for Food and Fibre Sciences – Fisheries and Aquaculture, Australia
Project Leader	Dr Mike Rimmer Ph: +62 813 6091 3790 Email: mikerimmer@iprimus.com.au
Collaborating Institutions	Southeast Asian Fisheries Development Centre, Philippines Central Research Institute for Aquaculture, Indonesia Research Institute for Aquaculture No. 1, Vietnam Network of Aquaculture Centres in Asia Pacific, Thailand Sam Ratulangi University, Indonesia Research Institute for Coastal Aquaculture, Indonesia Gondol Research Institute for Mariculture, Indonesia CSIRO Marine Research, Australia Directorate General Aquaculture, Indonesia
Project Budget	\$959,214
Project Duration	01/07/2004 to 31/12/2008 (Project extended from 01/01/2008 to 31/12/2008)
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Aquaculture is an important source of supply, particularly of high-value marine finfish. Interest in pursuing this has grown, reflecting both the incomes on offer to smallholders and the potential easing of pressure on wild stocks, both driven by the lucrative (up to US\$70/kg) paid in some parts of Asia.

The sustainability of aquaculture production continues to grow, as research delivers improvements to fish grow-out survival rates. ACIAR-supported research (FIS/1997/073) developed improved diets and rearing strategies for some species. Despite this success some problems remain to be addressed: wild fry and fingerlings being used as a source of seed stock, the poor survival in rearing from larvae and the role of trash fish (low value species usually found as by-catch in fishing for higher-value species).

With marine finfish playing an important role in the economic well-being of many coastal communities, ensuring the sustainability of aquaculture is important to maintaining wild

fisheries. Without such production, fishing pressure on wild stocks will increase, fisher folk will increasingly be forced to trawl for trash fish and increasing numbers of wild fry and fingerlings will be removed from wild populations to act as a source of seed stock. The overall objective of the project is to enhance the sustainability of marine finfish aquaculture in the Asia-Pacific region by improving hatchery production technology and facilitating the uptake of compounded feeds for grow-out.

Project Progress

Year 3 (01/07/2006–30/06/2007)

Overall, project progress is adequate, although some problems with the spawning performance of broodstock at Research Institute for Mariculture Gondol (particularly with coral trout) have caused some delays in project activities. Where possible, project activities have switched to other species to avoid further delays.

Collaborative work at Research Institute for Mariculture Gondol has shown promise for using Vitamin C to reduce deformities in larval and juvenile grouper. The optimum enrichment method of L-ascorbyl-2-monophosphate in *Artemia* was found to occur at a dose rate 0.9 g/L for 6 h. The highest percentage of abnormalities was found in grouper larva fed with unenriched *Artemia* and commercial diet (control), indicating that vitamin C has an important role in controlling abnormality of humpback grouper larvae.

However, it was noted that the deformities (nature and frequency) are highly variable, and that there may be some issues of consistency of results as a consequence.

Preliminary experiments done at Research Institute for Mariculture Gondol suggest that opercular deformities in juvenile grouper can be reversed using high doses of Vitamin C in the diet, but this finding requires more rigorous experimental follow-up.

Research into the digestive system of larval groupers has shown that they have weak enzyme activity during the endogenous nutrition stage of development (< Day 3 post-hatch) and that significant changes in enzyme activity correlate with digestive tract development events prior to Day 20 post-hatch. There are significant increases in the level of all enzymes after completion of stomach formation and onset of metamorphosis at Day 28 (tiger grouper) onwards.

Of four rotifer strains isolated from North Sulawesi, Manembo-nembo strain was found to be the smallest, and thus more suitable for first feeding of grouper larvae. The smallest rotifers (<120 µm) appear when cultured at salinities of 20 and 30 ppt for Manembo-nembo strain. There was no linear relationship between salinity and rotifer size.

Effect of dietary protein and lipid level on growth performance of tiger grouper during late-stage grow-out was evaluated at Research Institute for Mariculture Gondol using test diets with five levels of protein (38, 42, 46, 50, 54%) and two lipid levels (9, 15%). The results indicate that a dietary protein level of 38% is sufficient to support good growth of larger (>250g) tiger grouper. Fish fed high lipid diets were fatter and more energy of the diet was retained as body fat.

An evaluation of the digestibility of feed ingredients at RICA Maros has shown that tiger grouper efficiently digest animal feed ingredients, indicating that these ingredients have potential to be used as dietary replacements for fish meal. Some caution is advised for golden snail meal since its overall digestibility was inexplicably poor, perhaps indicating that unknown factors may be affecting its nutritional value. However, plant meals were less digestible than animal meals.

On-farm validation of grow-out feeds is being undertaken in Labuange Bay, Southern Sulawesi, where there are five commercial farms growing tiger grouper. Three treatments are being assessed: 'trash' fish, moist pellet, and commercial pellet. This trial started in April 2007 and is still under way.

The Asia-Pacific Marine Finfish Aquaculture Network (APMFAN) continues to expand. Formalisation of the network has begun with three Regional Resource Centres proposed for Indonesia as well as four for India. In addition, 25 Regional Resource Experts have been proposed.

The electronic dissemination of information continues to be popular with users. APMFAN eMagazine (four issues/year) averaged 1575 downloads; while the APMFAN eNews (monthly) averaged 600 downloads. Training news and reports downloads were >600–1,370. Around 30–40% of traffic on the NACA website discussion forums is related to marine finfish aquaculture. The 4th Regional Grouper Hatchery Production Training Course was held at the Brackishwater Aquaculture Development Centre Situbondo, 20 November–9 December 2006. Twenty participants from 13 countries successfully completed the course, including two participants from BADC Ujung Batee, Aceh (supported by FIS/2006/002).

APMFAN also organised a marine finfish hatchery training course on behalf of the Secretariat for the Pacific Community for a group of six from Pacific Islands in May 2007 at Krabi Coastal Fisheries Research and Development Centre (Krabi CFRDC) of DOF Thailand.

ACTIVE PROJECTS

Corporate sponsorship (from Skretting Asia) continues to contribute to support of APMFAN. The current agreement is to 2007–08 and includes:

- scholarships for grouper hatchery training course
- support for web site, news and communications
- further R&D cooperation and national marine fish aquaculture extension workshops are planned with additional funding support from Skretting Asia.

FIS/2006/099: Capacity building and technology transfer in applied population genetics of aquatic species in the south of Vietnam

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Queensland University of Technology, School of Natural Resource Sciences, Australia
Project Leader	Dr Peter Mather Phone: 07 3864 1737 Fax: 07 3864 2330 Email: p.mather@qut.edu.au
Collaborating Institutions	Research Institute for Aquaculture No. 3, Vietnam University of Fisheries, Vietnam
Project Budget	\$78,448
Project Duration	01/06/2007 to 30/06/2008
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

In wild fisheries, molecular genetic methodologies can provide an understanding of the scale and geographic pattern of differentiated populations (stock structure) and the degree to which individuals disperse among locations. This allows scientists to assess the spatial scale at which management should be implemented. Furthermore, a genetic approach to management provides a method for assessing the effect that harvesting can have on the genetic integrity (and hence long-term evolutionary potential) of populations, and can provide insights into potential consequences of translocations or local extinctions.

In aquaculture, additional issues arise that can be addressed by implementing a molecular genetic approach. To maintain high levels of productivity and long-term sustainability in culture lines, it is important to maximise genetic diversity across generations. For many culture species, animal breeders use mass spawning techniques as a standard approach for producing growout cohorts. This practice can lead to declines in genetic diversity in the fry as a result of specific mating behaviours (e.g. territoriality, harem etc) and/or non-random mating success.

Reductions in genetic diversity will increase the level of inbreeding and this may result in declines in stock productivity as a result of inbreeding depression. It can also reduce a population's potential to respond positively in stock improvement programs (e.g. via artificial selection to enhance important quantitative traits).

Senior scientist at Vietnam's Research Institute for Aquaculture No. 3 (RIA3) have identified building a strong capacity in applied genetics as a major goal, and recognise that any development in this area must be sustained for the future. The general objective of this project is to provide training, capacity building and experience in small model projects on local species of importance for RIA3 scientists destined to be part of the new applied genetics research group. An additional objective is to develop basic learning modules that could be incorporated into advanced undergraduate/postgraduate units for the University of Fisheries.

Project Progress

Year 1 (01/06/2007–31/05/2008)

First progress report due in 2008.

FIS/2006/144: Strengthening regional mechanisms to maximise benefits to small-holder shrimp farmer groups adopting better management practices (BMPs)

Bilateral

Overseas Collaborating Countries	India, Indonesia, Thailand, Vietnam
Commissioned Organisation	Network of Aquaculture Centres in Asia Pacific, Thailand
Project Leader	Dr C V Mohan Phone: +66 2 5611728 ext 115 Fax: +66 2 5611727 Email: mohan@enaca.org
Collaborating Institutions	University of Sydney, Australia Directorate General Aquaculture, Indonesia Department of Fisheries, Thailand Marine Products Export Development Authority, India Central Institute for Brackishwater Aquaculture, India National Fisheries Quality Assurance and Veterinary Directorate, Vietnam
Project Budget	\$77,190
Project Duration	01/06/2007 to 30/11/2009
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Better Management Practices (BMPs) in the aquaculture context outline norms for responsible farming of aquatic animals. In aquaculture, better management practices have been developed largely for shrimp and salmon aquaculture, although some efforts are presently being made to develop BMPs for other aquatic commodities (e.g. tilapias, catfish, molluscs, eels).

This project is building on the ongoing shrimp BMP programs in the Asia-Pacific region (e.g. in Australia, Indonesia, India, Vietnam and Thailand). It seeks to create a robust regional mechanism for networking and exchange of information, specifically focused to benefit small-scale shrimp farmers in Asia – to reduce disease risks, improve yields, produce quality shrimp, access better markets, address socio-economic sustainability and comply with international principles.

The project has the following objectives:

1. *Communications and networking* – To strengthen regional networking mechanisms between stakeholders for exchange of knowledge on BMPs, based on the International principles, to enable adoption to maximise benefits to smallholder shrimp farmers;
2. *Development and dissemination of contextualised BMPs* – To promote development and dissemination of contextualised BMPs for country/location/farming system/species;
3. *Forward integration* – To explore strategies that maximise market opportunities for BMP-compliant farmer groups;
4. *Farmer group certification* – To develop a methodology for enabling certification of BMP-compliant smallholder farmer groups.

Project Progress

Year 1 (01/06/2007–31/05/2008)

First progress report due in 2008.

FIS/2007/014: Dissemination of fisheries reservoir management extension materials in Vietnam

Bilateral

Overseas Collaborating Countries	Thailand, Vietnam
Commissioned Organisation	Network of Aquaculture Centres in Asia Pacific, School of Ecology and Environment, Thailand
Project Leader	Professor Sena De Silva Phone: 03 5563 3527 Fax: 03 5563 3462 Email: sena@deakin.edu.au
Project Budget	\$10,400
Project Duration	02/04/2007 to 02/07/2007
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Acting on the recommendation of the termination review of FIS/2001/013 *Culture-based and capture fisheries development and management in reservoirs in Vietnam*, ACIAR approved limited additional funds to cover the preparation and dissemination of extension and training materials, which would draw on the results of this and the related ADP/2000/018 *The economics of developing reservoir aquaculture in Vietnam*.

The Network of Aquaculture Centres in the Asia-Pacific (NACA) agreed to oversight the necessary action to develop and disseminate extension material to the desired professional standard.

Project Outcomes

The work entailed preparation of relevant extension material on culture-based fisheries in Vietnam. A small team of Vietnamese and Australian project scientists finalised an extension booklet and a poster, and now print runs of 1000 and 300 copies, respectively are in production. The booklet has been posted on the NACA web site (www.enaca.org) as well as that of the RIA1 site.

The Vietnamese team members are arranging distribution and the material will be used in further dissemination of culture-based fisheries development in Vietnam, primarily through the provincial administrations.

LPS/2002/078: Improved beef production in central Vietnam*Bilateral*

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Department of Primary Industries, Victoria, Australia
Project Leader	Dr Peter Doyle Phone: 03 58520503 or 03 58520500 Mobile: 0418 551 558 Fax: 03 58520599 Email: peter.doyle@dpi.vic.gov.au
Collaborating Institutions	Hue University of Agriculture and Forestry, Vietnam Quang Ngai Rural Development Program, Vietnam Quang Ngai Department of Agriculture and Rural Development, Vietnam
Project Budget	\$607,476
Project Duration	01/04/2004 to 31/12/2007 (Project extended from 01/07/2007 to 31/12/2007)
ACIAR Research Program Manager	TBA

Project background and objectives

In Quang Ngai Province and other areas of central Vietnam increasing the incomes of smallholder farmers is an important avenue to development. Smallholders have indicated that cattle rearing and finishing were the most desired income-generating activity. There is considerable market potential for selling cattle, but knowledge on cattle feeding systems is limited. ACIAR has supported research in this area which resulted in a workshop, during which both the income potential and value of future research were confirmed.

In 2000 data indicated cattle numbers in Quang Ngai at 224,000. Strong beef prices in the main urban areas and overall increases in national consumption have created a market that will continue to demand more beef. Cattle fattening in Quang Ngai Province has attractive returns to labour costs, but still faces some constraints to wider uptake.

Access to credit is a major constraint, as is farmer knowledge of cattle nutrition, production and health. Feeding options based around on-farm resources and supplemented by off-farm protein sources can reduce existing input costs, partially alleviating credit constraints.

The project will not, however, delve into credit access, instead focusing on feeding systems in their entirety. The project will link in with the Quang Ngai Rural Development Program to ensure extension activities are sustained beyond the life of the project.

Project Progress***Year 3 (01/04/2006–31/03/2007)***

The overall objective of the project is: to improve the profitability of finishing cattle by the development of year-round feeding strategies utilising on- and off-farm feed resources. The Project Coordinating Committee (PCC) that monitors progress of the stated objectives and milestones, and alignment of project activities with the needs of the Quang Ngai Rural Development Program (RUDEP) met once in November 2006 and contributed to the ACIAR review of the project in April 2007. At the November meeting the PCC reviewed all activities and discussed opportunities for new work post project LPS/2002/078 in a facilitated workshop.

Inventories of the availability and nutritive characteristics of feeds in the lowland and highland zones of Quang Ngai have been established in Activity 2. These pieces of work were largely completed in the previous year and activities over the last 12 months involved completion of reporting, finalising an extension booklet and inputting new information into the nutritive characteristics database.

The modelling approach used in ACIAR project AS2/1998/035 to designing possible year-round feed combinations has been further adapted for use in central Vietnam, but testing this approach against research

results (Activity 3) and in on-farm activities (Activity 4) has not progressed well. The departure of Clare Leddin from the project will hinder completion of this work.

Two feeding experiments conducted in Vietnam to provide data on live weight gain responses to different combinations of forage and locally available concentrate supplements have been written up for publication in scientific journals (Activity 3). Data from a third experiment have been analysed and a draft of a scientific paper prepared. The samples and data from a fourth experiment are being analysed.

Activity 3 in Victoria involved two major metabolism experiments examining associative effects between dairy cows fed perennial ryegrass hay or fresh Persian clover pasture and different amounts of crushed wheat. All laboratory analyses have been completed and the first experiment has been largely written up. The early results from these experiments have been used in awareness activities with service providers and dairy farmers.

Activity 4, 'Verification of feeding options in lowland farming systems', has involved working with farmers in Hanh Phuoc commune. Feeding interventions, designed using the research results from Activity 3 and in consultation with participating farmers, have been implemented in 20 households. The participatory approach, involving farmers and extension staff, in the design of feeding systems to be implemented has given those involved ownership and led to good commitment from the farmers. The early results of this study indicate improved weight gains and evaluations indicate the farmers find the technologies easy to implement and believe they have been profitable.

As part of Activity 5 'Increase the knowledge and technical skills of scientists and extension staff in Vietnam and Australia' the project team has published three journal papers and one conference paper, and submitted one other journal paper for publication. Nguyen Xuan Ba was awarded a John Dillon Fellowship and Clare Leddin undertook a leadership course within DPI. At HUAF, one postgraduate and several undergraduate students participated in Activity 3, and three students have been involved in Activity 4 in Quang Ngai.

LPS/2002/079: Utilisation of local ingredients in commercial feeds for pigs*Bilateral*

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Animal Research Institute, Australia
Project Leader	Dr John Kopinski Phone: 07 3362 9404 Fax: 07 3362 9429 Email: john.kopinski@dpi.qld.gov.au
Collaborating Institutions	Institute of Agricultural Sciences of Southern Vietnam, Vietnam Southern Sub-Institute of Agricultural Engineering and Post-Harvest Technology, Vietnam
Project Budget	\$400,001
Project Duration	01/04/2004 to 30/06/2008 (Project extended from 01/04/2007 to 30/06/2008)
ACIAR Research Program Manager	TBA

Project background and objectives

The pig production sector in Vietnam is an important avenue for smallholders to earn additional income. Increasingly smallholders are entering the commercial arena, responding to the demand for lean pig products, a valued source of human dietary protein.

The major constraint to increased smallholder involvement in the commercial sector and to the long-term viability of commercial operations is the cost of feed. Traditional feeds are based on grains and protein-rich components. Prices are being driven up by the increasing global demand for grains.

In Vietnam smallholders utilise a variety of feed stuffs, despite limited knowledge concerning their value. Commercial imperatives, however, require feeds that maximise performance and meat quality.

A past project which delivered improved pig genotypes, also examined dietary feeds. Many hundreds of components are available but their value in terms of maximising performance and meat quality is unknown. This project is assessing the suitability of some locally available protein and energy sources as components of commercial pig diets. Adoption of these outputs is intended to lead to reduced prices of commercial complete and concentrate diets and to reduce reliance upon imported dietary components.

Project Progress***Year 3 (01/04/2006–31/03/2007)***

Following the detailed cyanide processing studies in Australia Vietnamese project staff repeated the identified successful protocols in Vietnam. During 2006 additional fresh rubber seed were harvested from plantations in Vietnam. These were frozen and bulked together. Sub-samples of these underwent a number of treatments using press oil extraction, washing and sun drying. These were then chemically analysed for presence of residual hydrogen cyanide (HCN). This was an up-scaled replication of the protocols initially carried out successfully in Australia on smaller samples. Also this protocol was carried out on much fresher rubber seed material which it is believed generally had a higher cyanide content initially.

Research results indicated that the processing protocols identified were successful in substantially reducing the cyanide level in rubber seed. However the particularly good results in Australia, achieved previously on smaller rubber seed quantities, may have raised Vietnamese expectations of total elimination of cyanide.

Information from the literature and our own chemical studies have indicated that the age of the rubber seed and its storage conditions post-drop will affect the relative proportion of oil, moisture and the level of HCN detected in the seed. Consequently these parameters

will also influence the protocol used and the relative success of selected processing protocols implemented to reduce HCN and the degree to which the HCN is reduced.

Further to the primary role of the processing protocol to reduce cyanide, it is important to note that whichever protocol is selected it will also significantly affect the cost of the final product derived and could also influence the proximate chemical composition, amino acid content and ultimately the nutritive value of the processed feed ingredient.

Our processing revealed that following the protocol recommended could consistently reduce the cyanide level to <20 mg/kg. Additionally as rubber seed meal inclusion will never be 100% then this would mean the residual level of cyanide in pig diets containing rubber seed would be substantially less than this. Currently some further studies are being carried out to examine the ratio of water to seed, time and temperature on cyanide reduction. As the actual age of the seeds was unknown there is a possibility that the endogenous cyanide releasing enzymes are themselves been affected by the age of the seed and hence the apparent higher residual cyanide level following processing.

During a project meeting in Vietnam a number of cassava processing plants were visited. This enabled an understanding of the processing to obtain cassava residue and how the material was on-processed into a feed ingredient material. Based on these observations it appears that there may be an opportunity to utilise the spare capacity of these cassava processing plants, and via additions and modification develop a commercial rubber seed processing industry.

Pig digestibility studies and dietary inclusion feeding studies on cassava residue were completed and these will provide valuable information on the nutritional value of this by-product and the levels at which it can be effectively and safely used. Due to Vietnamese concerns on residual cyanide content in rubber seed the *in vivo* digestibility and feeding studies planned for this feed ingredient have been put on hold until the matter has been clarified, and pending the arrival of the next uniform fresh batch of rubber seed.

In Australia the digestible energy content of a number of sunflower meal types available have shown major differences in their energy value based on processing. Additionally, amino acid analysis has shown a significantly lower lysine content than previously reported. Further work to examine these apparent changes has been delayed due to difficulty in sourcing material as a result of the drought.

LPS/2004/073: Capacity building on cattle production at Dong Giang district, Quang Nam province, Vietnam

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	World Vision of Vietnam, Vietnam
Project Leader	Mr Sujeevandas Phone: +84 4 943 9920 Email: jij_sujeevandas@wvi.org
Project Budget	\$74,800
Project Duration	01/04/2005 to 31/03/2009
ACIAR Research Program Manager	TBA

Project background and objectives

World Vision Vietnam has implemented projects for the poor in Dong Giang District (Quang Nam province, central Vietnam) to improve their living standards through activities such as health services, education and livestock development. This initiative will augment the World Vision Vietnam Area Development Plan by improving the capacity of World Vision staff and community leaders in administrating and managing projects.

Extension staff in the district and communes will gain in technical and extension knowledge. Local people will be exposed to applying suitable technologies to improve cattle productivity. It is anticipated that improved cattle production and increased income from livestock for participating households will be achieved within the project period, with wider scale benefits in the longer term.

Project Progress

Year 2 (01/04/2006–31/03/2007)

HUAF staff members have conducted capacity-building activities in Dong Giang each month for representatives of the District, World Vision staff, extension staff, para-vets, farmers and farmer associations in the following:

- general course in cattle production
- feeding and nutrient requirements of cattle
- Quang Ngai study tour
- extension methods
- establishing cattle demonstration models in three communes
- up-skilling hamlet facilitators (five communes).

A stakeholder workshop was held in Hue in August 2006, to consider the activities that had been undertaken, their benefits, the challenges and future opportunities.

FIS/2003/003: Stock structure of two important Mekong River carp species (*Henicorynchus* spp.)

Bilateral

Overseas Collaborating Countries	Cambodia, Laos, Thailand, Vietnam
Commissioned Organisation	Queensland University of Technology, School of Natural Resource Sciences, Australia
Project Leader	Dr Peter Mather Phone: 07 3864 1737 Fax: 07 3864 2330 Email: p.mather@qut.edu.au
Collaborating Institutions	Mekong River Commission, Fisheries Programme, Cambodia Living Aquatic Resources Research Centre, Laos Department of Fisheries, Thailand Research Institute for Aquaculture No. 2, Vietnam
Project Budget	\$386,968
Project Duration	01/01/2004 to 31/03/2007 (Project extended from 01/01/2006 to 31/03/2007)
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

The Mekong River Basin is home to fisheries which provide food security for approximately 60 million people spread across several countries. Despite their importance management of these fisheries is rudimentary at best. The Mekong River Commission (MRC), formed under the cooperation of the four countries sharing the lower parts of the basin, have begun to focus on achieving sustainable fisheries management to ensure food security is maintained, while also factoring in growing development pressures on the river.

The basin offers a wide range of agricultural and industrial development opportunities.

Hydrological power development is one such opportunity that threatens fisheries, while the importance of the river as a trade link between the six riparian countries through which it runs, is also likely to increase. Population increases will continue to put further pressure on the surrounding environment and river system itself, as well as on the capabilities of Mekong fisheries.

Management of these fisheries is complicated by the high level of diversity of fish species. Sustainable management practices can vary between species depending on ecology and life histories. The MRC has initiated extensive studies of the ecology of a number of important fish species to understand ecology and life histories better. The use of genetic

methodologies for identifying discrete gene pools has not been used in the Mekong. Elsewhere these techniques are being applied to dish stock discrimination to form the basis of fisheries management plans. The application of these techniques is possible for the Mekong and will be trialled.

Project work will determine the pattern of genetic structure of two economically important carp species (*Henicorynchus siamensis* and *H. lobatus*) as models and to develop an appreciation of the conceptual basis, data interpretation and application of molecular population genetic analysis to fisheries management in the MRB.

Project Outcome

The major objective of this project was to demonstrate the utility of a molecular genetics approach to stock identification for Mekong River Basin fish species. As such, two important carp species (*Henicorhynchus* spp.) were targeted for molecular analysis of mtDNA sequences of samples collected from right across the lower Mekong Basin (LMB) with assistance from MRC scientists from the four countries (Vietnam, Thailand, Cambodia and Lao PDR).

The study results showed that the two species, while possessing very similar morphologies (often they are confused in the field), had very different demographic histories and most probably will be seen to

possess very different ecologies once the studies are conducted. Patterns of genetic diversity were very different in the two species with two discrete stocks identified in the LMB for *H. siamensis* and three discrete stocks identified for *H. lobatus* with quite different distributions.

Additional stocks were detected for both species in adjacent drainages, indicating that evolution of genetic diversity in the region in these fishes has been a complex process and probably is related to changes in the paleogeography and river basin evolution of the MRB. These data can provide the foundation for establishing effective management units for fish stock conservation for both species in the future by the MRC. It is likely that each of these stocks may require independent management practices to be developed to maintain populations into the future.

In parallel with the genetic diversity studies undertaken at Queensland University of Technology (QUT) for the two model species, a series of training workshops and a *Masterclass in microsatellite analysis* were conducted for national scientists attached to the project. These provided a foundation to the theory and practice of molecular diagnosis of fish stocks using this approach. In addition, a number of regional scientists received short course training at QUT and some have commenced or will shortly commence postgraduate degrees that include significant exposure to the genetic technologies employed in the current project.

This in parallel with the development of a new 'state of the art' molecular genetic research facility at Research Institute for Aquaculture No. 2 means that in the near future the MRC and member countries will have access to both facilities and trained staff. These additions will enable them to commence routine application of the molecular approaches to fish stock identification demonstrated in the current project.

7.2 Subprogram 2: Optimising water and soil management for sustainable production, particularly on degraded lands

Projects:

Active

- FST/1999/095 Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: genetics and silviculture
- FST/2001/021 Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying
- FST/2002/112 Domestication of Meliaceae species in South-East Asia and Australia, particularly management of the problem of *Hypsipyla robusta* attack
- FST/2003/002 Development and evaluation of sterile triploids and organisation breeding methodologies for commercial species of *Acacia* in Vietnam, South Africa and Australia
- SMCN/2002/015 Managing groundwater access in Tay Nguyen (Central Highlands) Vietnam
- SMCN/2002/085 Utilising basic soil data for the sustainable management of upland soils in Vietnam and Australia
- SMCN/2003/035 Improving the utilisation of water and soil resources for tree crop production in coastal areas of Vietnam and New South Wales

Concluded

- FST/2000/003 Mixed species plantations of high-value trees for timber production and enhanced community services in Vietnam and Australia
- FST/2007/025 Socio-economic factors influencing smallholder production of acacia sawlogs in Vietnam

Pipeline

- FST/2006/087 Improved site management for fast-growing plantations in Vietnam

FST/1999/095: Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: Genetics and silviculture

Bilateral

Overseas Collaborating Countries	China, Vietnam
Commissioned Organisation	State Forests of New South Wales, Tree Improvement, Australia
Project Leader	Mr Michael Henson Phone: 02 6650 5703 Email: michaelhe@sf.nsw.gov.au
Collaborating Institutions	Guangxi Forest Research Institute, China China Eucalypt Research Centre, China Queensland Department of Primary Industries and Fisheries, Australia Hunan Provincial Forestry Department, China Chinese Academy of Forestry, China Forest Science Institute of Vietnam, Vietnam
Project Budget	\$682,611
Project Duration	01/07/2005 to 30/06/2009
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Global demand for high-value hardwood timber is growing. There are two available sources of supply; native forests and plantations. Supply from native forests is under increased pressure, with less available areas for logging and a greater emphasis on conservation. This diminishing number of native forests has seen a rise in plantations of short-rotation hardwood species.

One of the limitations in growing short-rotation plantations is the difference in timber quality. Native forests take longer to mature, resulting in bigger and more robust log sizes that stand up to the stresses of sawing and processing. Plantation-derived logs have smaller diameters making them more prone to splitting, bending and curving during processing and sawing. Many plantations provide wood as a source of short fibre pulp and increasingly as a replacement for native forest products when this timber is in short supply.

In China, Vietnam and Australia an increased emphasis on conservation has contributed to reduced logging of native forests. This has increased the use of plantation timber in processing. Improving the useability of this young timber depends on understanding the impacts of growth stresses on wood properties and how these contribute to problems in sawing and processing. Such an understanding would help in guiding the choice of eucalypts suitable for short-rotation use and in the silvicultural management of these species.

This project aims to improve the economic returns to growers and processors from eucalypt plantations by developing and implementing silvicultural and genetic strategies to optimise yields of high-quality timber from eucalypt plantations in China, Vietnam and Australia by improving wood properties.

Project Progress

Year 2 (01/07/2006–30/06/2007)

The project completed several major wood quality assessments in key trials in all partner countries (China, Vietnam and Australia). Silvicultural and genetic trials across a range of *Eucalyptus* species have been assessed for a range of wood properties. Harvested logs with known wood properties from all of these trials were provided to FST/2001/021 for a range of sawing, veneer and drying trials.

Results of the genetic and silvicultural traits of wood properties are still being analysed as well as the evaluation of a range of non-destructive assessment techniques. Wood quality assessments were completed on the following trials as part of the project.

Australia

- *Eucalyptus nitens* Provenance Trial (17 years)
- *Eucalyptus pilularis* Progeny Trial (9 years)

Vietnam

- *Eucalyptus urophylla* Progeny Trial (10 years)
- *Eucalyptus pellita* Progeny Trial Vietnam – pilodyn only (6 years)

China

- *Eucalyptus urophylla* x *grandis* Spacing and Fertiliser Trial (13 years)
- *Eucalyptus* Hybrid Clone Trial (15 years)

Preliminary results of the studies have been presented at conferences and workshops in China and Australia, and it is hoped that many of the results will be published in peer reviewed journals.

Results from an assessment of a spacing fertiliser trial in Guangxi southern China suggested that variations in establishment spacing resulted in major diameter differences with minimal impact on the fundamental wood properties.

A plan for additional work was prepared for the Hunan Forestry Department (one of the Chinese project partners) in December 2006, and the Hunan team have received additional provincial funding to enable them to complete the work plan. This will allow Hunan to establish and assess additional species, genetic and silvicultural trials over the life time of the project.

With the majority of the large wood quality assessments now complete the project is now moving in to a phase of analysis, modelling and evaluation of the economics of the results working in close collaboration with the team of FST/2001/021 in the three countries.

Training was provided to both Vietnamese and Chinese collaborators “in-country” in the use of standing tree and log assessment techniques to evaluate wood property. In both countries there has been considerable uptake of these methods, where in China several MSc theses have been completed utilising equipment and methods provided by ACIAR.

With co-funding from ATSE Crawford Fund two Chinese and one Vietnamese collaborator attended the inaugural Australasian Forests Genetic Conference in Hobart, Tasmania where several papers were presented on work associated with project FST/1999/096. After the conference the three delegates attended a course on using the statistical package ASREML for the analysis of genetic trials.

This was followed by a week’s course in non-destructive assessment of standing tree wood quality in northern NSW hosted by Forests NSW and Southern Cross University.

FST/2001/021: Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying

Bilateral

Overseas Collaborating Countries	China, Vietnam
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Dr Russell Washusen Phone: 03 9545 2173 Fax: 03 9545 2133 Email: russell.washusen@ensisjv.com
Collaborating Institutions	Forest Science Institute of Vietnam, Vietnam China Eucalypt Research Centre, China
Project Budget	\$519,932
Project Duration	01/07/2005 to 30/06/2009
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Traditional wood processing industries have utilised native forests for timber. As a result the industries in China and Vietnam, as elsewhere, have evolved processes for wood sawing that match the timber's used.

Increasing demand for timber has placed the burden of production on native forests, many of which are now in decline. Harvest restrictions are now being applied in China and Vietnam, limiting timber production from native forests. With these restrictions have come pressures on employment and a greater reliance on timber importation, creating trade imbalances.

A solution is planting eucalypts, together with other species as part of reforestation programs. Eucalypts primarily supply raw material for large industries: pulp and paper, fibreboard and chipping. Small-scale use in traditional industries is also undertaken, such as for furniture and joinery. Mainly small diameter logs (less than 30 cm) are used, but growth stresses are released when these are sawn using traditional approaches, splitting logs and rending them useless. Such constraints and tendency of plantation-grown eucalypt wood to distort have discouraged use.

The objectives of this project are to:

- improve the efficiency of processing of small diameter plantation grown eucalypt logs for solid wood products
- increase returns to plantation growers
- assist in the development of viable rural industries in China, Vietnam and Australia.

Project Progress

Year 2 (01/07/2006–30/06/2007)

Project FST/2001/021 continued to develop joint activities with FST/1999/091, by conducting processing trials using plantation material assessed in the field by FST/1999/091. This also involved engagement of industry in China, Vietnam and Australia. Major contributors were N. F. McDonnell & Sons (Victoria), Forest Enterprises Australia, the Dongmen veneer factory (China), Pisico (Vietnam), Raute (Singapore) and Veisto Oy (Finland).

During the reporting period preparations were made for three processing trials (one each in China, Vietnam and Australia), and three others (one in China and two in Australia) commenced or were completed.

A report on the first of the processing trials has been completed. This was a sawing trial with ~135 logs conducted in collaboration with Forests NSW and N.F. McDonnell & Sons in Victoria using four provenances of *Eucalyptus nitens* (17-year-old plantations located near Tumut NSW) with measured peripheral growth strain levels, acoustic wave velocity (AWV) and Pilodyn measurements.

The aim was to assess the capacity for these measurements to predict log and sawn board behaviour during harvest log handling and sawing. Sawing was conducted with a HewSaw R250, a single pass sawing machine developed by the Viesto Group in Finland that applies chippers and saws more-or-less simultaneously. The chippers which profile the cants appear to remove sufficient high stressed wood to allow sawing to proceed with little difficulty.

The major findings from this research were that growth strain was only moderately useful in predicting growth stress related log and board behaviour, AWV was found to be a good predictor of log and board end splitting and could be used to predict recovery of sawn boards after docking end splits. Bow in sawn boards was the only important board behaviour characteristic related to growth stress release during sawing. Generally, this was of limited extent and not sufficiently severe to prevent major problems during transport and stacking of the boards. There was some provenance variation detected in log and board end-splitting and bow in sawn boards suggesting some potential improvement in performance.

A second report has been prepared for a trial conducted at the Dongmen Forest Farm, Guangxi Province, China. This trial was a departure from proposed work because adequate sawing equipment could not be located in this region of China. To overcome this difficulty logs were peeled, then the peeled veneer sheets kiln-dried using standard processing methods for the production of internal grade veneer at the veneer factory in Dongmen. The trial used ~160 logs from a single clone of 12-year-old *E. urophylla* x *grandis* from a spacing trial located in the Dongmen Forest Farm, testing six spacing treatments. Growth strain, AWV and a number of other standing tree measurements were assessed for their potential to predict veneer recovery and quality.

The main findings were that growth strain was a moderate predictor of log-end splitting. On this occasion AWV was not a significant predictor of log end splitting. There was a significant effect detected for spacing treatment on recovery and value of veneer that was related to diameter growth. Models were developed that could predict recovery and product value based on log external features that could be used to value logs. Simulations suggest that there are likely to be substantial improvements in product quality with pruning as branch related defects were clearly the major grade limiting factor. Even greater improvement in product quality and value may be achieved with the production of appearance grade veneer.

In addition to pruning trees a number of changes to processing methods would be required such as the application of pre-heating of logs, conveyors to transport veneer, and restraint in driers to prevent buckling and splitting of veneer. Log-end splitting may also need to be reduced if appearance grade veneer were produced, however, this was not specifically tested in this research.

A third trial conducted with the HewSaw R200 at the FEA sawmill in Tasmania with ~480 logs from a Forests NSW *E. pilularis* family trial (10-year-old plantations located near Port Macquarie, NSW) is complete. A subset of ~160 logs was intensively measured to examine log and board behaviour as for the *E. nitens* trial above, so that comparisons can be made between trials. Product quality and value, board shrinkage and major grade limiting defects have been recorded for all logs. Financial modelling of the processing will be conducted using the financial analysis methodology in CSIRO MILL, based around a module developed specifically for the HewSaw R200. Veisto Oy in Finland has been engaged to assist with input data to develop this module of CSIRO MILL.

A processing trial is currently being planned for thinned 11-year-old *E. urophylla* from a family trial at Ba Vi in northern Vietnam. This will be conducted at the Pisico sawmill at Quy Nhon in central Vietnam. Sawing will be undertaken with a horizontal band saw followed by application of sheltered air drying, steam reconditioning and kiln drying. This trial will apply standard sawing patterns for teak and a modified cutting pattern to assess the potential to reduce board end splitting.

This project will also be conducted jointly with another funded by MARD to compare a number of drying strategies for *E. urophylla* from central Vietnam. As with the completed processing trials, growth strain and AWW from standing trees or logs will also be assessed for their potential to predict log and board behavioural characteristics with growth stress release. One processing trial in Lizhou, China using ~16-year-old *E. dunnii* and one at the FEA mill in Tasmania with CCV from Queensland are currently being planned.

Assessment of the SilviScan technology in application for improvement in eucalypt resources for solid wood processing end-uses has also been completed and a report submitted to ACIAR.

SMCN/2002/015: Managing groundwater access in Tay Nguyen (Central Highlands) Vietnam

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Australian National University, National Centre for Development Studies, Australia
Project Leader	Professor Jeff Bennett Phone: 02 6125 0154 Fax: 02 6125 8448 Email: jeff.bennett@anu.edu.au
Collaborating Institutions	Tay Nguyen University, Vietnam Ho Chi Minh City University of Economics, Vietnam Department of Water Resources Management, Vietnam
Project Budget	\$399,112
Project Duration	01/01/2005 to 31/12/2007
ACIAR Research Program Manager	Dr Gamini Keerthisinghe

Project background and objectives

The Tay Nguyen (Central Highlands) region is Vietnam's leading coffee producer. The region also supplies agricultural and forestry products for domestic markets and export. It covers approximately 17 per cent of Vietnam's land area, including 16 per cent of total arable land and 22 per cent of forested land. In recent years drought has reduced coffee production – in 2003 by an estimated 25 per cent. Domestic water supplies were also threatened. Drought, however, was not the only factor in production declines and water shortages.

Vietnamese Government policies have encouraged the intensification of agricultural and agroforestry practices over the past three decades. Population growth has since resulted during the same period, intensifying resource use, including water. Much of the increased agricultural production has been based on cropping, with deforestation providing cropping land and increasing water use.

Current groundwater extraction practices to support and underpin much of this agricultural expansion are unsustainable. Recent droughts exacerbated the threat to groundwater and agricultural production but were not the main cause of concern. If left unaddressed sustainable farming will collapse and the economic, social and environmental impacts, both to the region and Vietnam could be severe. Salinity and nutrient depletion, now becoming evident have the potential to be widespread,

production will decline in key industries and unemployment rise.

The project aims to:

- understand the dynamics of groundwater flows in the Tay Nguyen region and to employ these data to analyse the physical impacts of alternative use regimes over the forecast period;
- determine the use allocation of groundwater resources that provide for social improvements on the basis of economic, social and environmental criteria using extended cost-benefit analysis;
- consider alternative policy options for securing improved groundwater use practices and determine the most practical and cost-effective institutional framework to provide incentives for the improved use of the resource using the New Institutional Economics framework;
- facilitate the use of the research findings in the development of policy initiatives and institutional frameworks;
- build the capacity of Vietnamese scientists and organisations involved in resource and environmental management.

Project Progress

Year 2 (01/01/2006–31/12/2006)

Two major data collection activities were undertaken in 2006. Both involved the application of stated preference techniques to estimate non-marketed values associated with water use in Dak Lak. Both involved respondents from Buon Ma Thout (BMT) being interviewed by survey enumerators from Tay Nguyen University and Ho Chi Minh City Economics University.

The first used the contingent behaviour approach to estimate the value of additional water supply to domestic consumers in BMT. The second used the contingent valuation technique to estimate the values held by BMT and surrounding area residents of a coffee grower education program that would result in a range of agro-environmental benefits, including increased dry season river flows. The focus of the coffee grower extension program was on the reduction in irrigation water required to ensure bud burst; this was analysed from a hydrological perspective in the first year of the project.

Both studies involved thorough questionnaire development including pre-testing. Questionnaires were designed in both English and Vietnamese. Sampling was based on a geographical stratification process. Data coding was performed by the survey enumerators. Approximately 800 households participated in the two surveys.

The data from the two stated preference surveys have been analysed and draft reports prepared. Team members from Ho Chi Minh City Economics University had prime responsibility for the contingent valuation analysis whilst the ANU team members led the contingent behaviour analysis. The questionnaires developed for these studies and the methods of data analysis employed involved path-breaking conceptual and practical developments.

Of particular note are key features that specifically took into account the developing-country context of the applications. For instance, the contingent behaviour application involved the checking of respondents' statements regarding water usage through the measuring of water used in particular household tasks. In the contingent valuation questionnaire, certainty measures were collected as part of the willingness to pay questioning process, increasing the reliability of the data.

The economic values of water obtained from this research can be used as a part-basis for evaluating the social welfare impacts of water allocations in Dak Lak. In water scarce regions, Vietnam's Law on Water Resources requires this type of analysis for river basin planning. To the project team's knowledge, this is the first time household water demand functions have been estimated in rural Vietnam. It is also the first time environmental flow values have been estimated.

In addition, data analysis of the farm survey data collected as a project component in 2005 was carried out. Based on the farm survey results, the water crop production function for dry season irrigated rice was estimated. Using a simulation-optimisation approach, dry season water requirements under economically optimal irrigation scheduling have been identified.

The results of this research suggest substantial scope exists in Dak Lak for increased irrigation efficiency in rice production and that increasing plot-level irrigation efficiency will improve economic returns to rice farmers. Because dry season irrigated rice production has the second greatest volumetric demand for water after coffee in Dak Lak, potential off-farm benefits are also evident from increasing plot-level irrigation efficiency.

In the course of the farm level data analysis, some limitations in the coffee irrigation information were uncovered. These provided key restrictions to the production function estimation process for coffee, necessitating the commissioning of a follow-up questionnaire that is to be undertaken in early 2007.

SMCN/2002/085: Utilising basic soil data for the sustainable management of upland soils in Vietnam and Australia

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Queensland Department of Natural Resources and Water, Australia
Project Leader	Dr Philip Moody Phone: 07 3896 9494 Fax: 07 3896 9623 Email: phil.moody@nrw.qld.gov.au
Collaborating Institutions	Institute of Agricultural Sciences of Southern Vietnam Soils and Fertilisers Institute, Vietnam World Vision of Vietnam, Bac Binh Area Development Program, Vietnam
Project Budget	\$395,995
Project Duration	01/01/2004 to 31/12/2007 (Project extended from 01/07/2007 to 31/12/2007)
ACIAR Research Program Manager	Dr Gamini Keerthisinghe

Project background and objectives

Traditional subsistence agricultural systems based on slash-and-burn practices have degraded soils in upland areas of Vietnam's central highlands. Extensive deforestation and land clearing have resulted, leading to erosion and soil fertility declines. Ethnic minorities who have practised this style of agriculture have high levels of poverty, and little knowledge of other agricultural practices.

The Vietnamese Government has encouraged these minorities to settle in villages and undertake permanent agricultural production in surrounding areas. Soil productivity in these areas remains low, with knowledge of practices to ensure long-term sustainability negligible. Constraints to productivity are numerous and include nutrient deficiencies and toxicities in soils, and soil compaction.

A variety of soil information has been collected, mainly for soil classification purposes. Despite this information being available, little has been made of the data in terms of assessing soil productivity constraints. A simple Soil Constraints and Management Package ('SCAMP') that uses measures and properties (texture, colour, etc.) of collected soil, or soil examined in the field, to identify constraints and indicates appropriate management strategies exists.

Scaling this up for interpretation of soil constraints and management strategies to ameliorate or manage these at the village level is needed to help develop improved practices.

The project will provide a decision support framework that allows basic soil information to be interpreted in terms of soil constraints to productivity and to be synthesised into management strategies appropriate for maintaining the long-term productivity of upland soils. This will enable results obtained in a site-specific context to be applied at the provincial/catchment scale through the use of existing geo-coded soil survey data and SCAMP.

Project Progress

Year 3 (01/01/2006–31/12/2006)

Key results and activities of 2006 include:

Vietnam

In the 2006 growing season, a second maize crop was grown on the Ferralsol site at Ia Kha. Maximum grain yield (4.7 t/ha) was obtained in the treatment where *Tithonia* residues at the rate of 1t/ha were mixed through the planting row soil to a depth of 10 cm (1/3 total area) and additional NPK fertiliser was applied to meet the recommendation of 115N 42P 100K.

It is likely that the success of this treatment was due to the correction of excessive soil acidity (soil pH was increased) and the gradual release of N and P from the plant residues better matching crop demand than in treatments where inorganic fertiliser was applied. This treatment also provided the highest gross margin of 7.1 million VND/ha.

A maize field experiment was also carried out on an Acrisol soil in Dak Po at a site (Tan An village) different from where the 2005 Acrisol experiment was undertaken. The highest grain yield (5.3 t/ha) was obtained where the fertiliser recommendation (92N 29P 75K) had been applied together with 10 t/ha bentonite mixed through the planting row soil to a depth of 10 cm (1/3 total area) to increase cation exchange capacity (CEC) and water-holding capacity.

However, the maximum gross margin (9.2 million VND/ha) was obtained from the treatment receiving the fertiliser recommendation and where mounding and application of roots and stems of *Peuraria* and *Mucuna* at 500 kg/ha had been used to improve soil structure and drainage. The grain yield from this treatment (5.2 t/ha) was not much less than the former treatment. These results suggest that drainage and soil physical characteristics are constraints to productivity for this soil. The results from the field trials support the conclusion of the previous year's trials that soil-specific management practices are needed for sustainable productivity.

Field data and lab analyses for the soils collected during the Ferralsol transect and the Acrisol soil survey have been input into the SCAMP database and constraints and management strategies identified as outputs. Data summary reports and SCAMP constraints reports have been produced for each of the 14 Ferralsol and 16 Acrisol sites.

Australia

A second draft of the SCAMP Field and Laboratory Handbook has been prepared. Compared to the first draft it contains:

- more interpretive information on the Emerson dispersion test
- a table using structure, texture, mottling and colour to assist in the allocation of drainage and permeability ratings.

These modifications have not yet been translated into Vietnamese. The first draft in Vietnamese is still the resource for the training workshops held for agricultural extensionists in Vietnam.

A major enhancement to SCAMP has been the development of the 'Safegauge for Nutrients' decision support system (DSS). This DSS will import basic soil information from the SCAMP database to allocate a qualitative risk of off-site nitrogen and phosphorus movement as a result of fertiliser practices.

The DSS allows the user (extensionist, farmer) to assess the effects of different fertiliser management scenarios (time of application, method of application, rate of application, fertiliser form) on risk. Following anticipated completion by mid 2007, the SCAMP-Safegauge DSS will be trialled by a group of Queensland canegrowers to assess its usefulness as an awareness/education package for the Australian sugar industry.

SMCN/2003/035: Improving the utilisation of water and soil resources for tree crop production in coastal areas of Vietnam and New South Wales

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Southern Cross University, Australia
Project Leader	Dr Peter Slavich Phone: 02 6626 1352 Fax: 02 6628 1744 Email: peter.slavich@dpi.nsw.gov.au
Collaborating Institutions	Vietnam Academy of Agricultural Sciences, Vietnam Soil and Fertiliser Research Institute, Vietnam Department of Agriculture and Rural Development, Ninh Thuan, Vietnam
Project Budget	\$666,198
Project Duration	01/01/2007 to 31/12/2009
ACIAR Research Program Manager	Dr Gamini Keerthisinghe

Project background and objectives

The coastal provinces of central Vietnam are amongst the poorest in the country because agricultural development is hampered by lack of water combined with sandy soils that are infertile and difficult to irrigate. A promising approach to improve agricultural development in this region is expansion of cashew nut production using small-scale farm dams to capture wet season runoff and irrigation technologies that are economically and socially appropriate. There is also potential to improve soil fertility and integrate nut production with forage production using groundcover species such as *Arachis pintoii* (perennial peanut).

The objectives of the project are to improve smallholders' incomes by improving the profitability of cashew nut production. The project will demonstrate the potential for developing and utilising small-scale on-farm water storages, evaluate the use of waste materials as soil amendments for improving water- and nutrient-use efficiency, and promote strategies that will enhance adoption of management strategies which enable high irrigation efficiency and long-term soil fertility improvement in Vietnam and NSW.

Project Progress

Year 1 (01/01/2007–31/12/2007)

First progress report due in 2008.

FST/2000/003: Mixed species plantations of high-value trees for timber production and enhanced community services in Vietnam and Australia

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	University of Queensland, Department of Botany, Australia
Project Leader	Associate Professor David Lamb Phone: 07 3365 2045 Fax: 07 3365 1699 Email: d.lamb@botany.uq.edu.au
Collaborating Institutions	Forest Research Centre, Vietnam Queensland Department of Primary Industries and Fisheries, Australia
Project Budget	\$939,848
Project Duration	01/01/2002 to 30/06/2006 (Project extended from 01/01/2006 to 30/06/2006)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Forest cover in Vietnam declined from 44 per cent in the early 1940s to 24 per cent by 1983. Similar declines have occurred in most other tropical countries, including Australia. In Vietnam, the decrease in the supply of goods and services from forests has had a profound effect on rural communities and the nation as a whole. Supplies of building timbers and fuelwood have declined along with the availability of many non-timber forest products such as herbs and medicinal plants.

Erosion has increased, causing siltation of rivers, irrigation canals and dams. There has also been a decline in soil fertility in many areas. Inevitably, forest fragmentation and loss has diminished the country's overall biological diversity. Reforestation is therefore a high priority. The Government is now preparing the Five Million Hectare Reforestation Program (5MHRP), which aims to lift the forest cover of Vietnam back to 43 per cent over 10 years. This reforestation will more likely be carried out by smallholders rather than government agencies.

Much of the previous reforestation effort in Vietnam used exotics such as *Eucalyptus* and *Acacia*, which are fast-growing species that tolerate poorer soils. While these will continue to have an important role, there is also considerable interest in using more indigenous and higher value species. The habitat preferences and silvicultural requirements are known for only a few of these species. This represents a serious impediment to the 5MHRP, because if species are planted at inappropriate sites the reforestation effort may fail.

A further difficulty is that many indigenous species are now being planted in *ad hoc* mixed-species plantations. Mixed plantations can offer some significant advantages, but only if the species concerned are complementary. Random assortments are unlikely to provide advantages and are more likely to reduce productivity or even fail. Research is therefore needed to define the attributes of complementary species and to identify those situations where mixtures can be advantageous (or where they should not be used).

The project is working to develop silvicultural techniques so that greater use can be made of indigenous and other high-value tropical tree species in reforestation projects in Vietnam and Australia.

Project Outcome

Surveys of existing tree plantations found a large number of species (>64 species) are currently being grown by farmers. These include native and exotic species being grown on short and long rotations. Most of these trees are <15 years old and were established following the period of doi moi or de-collectivisation in the late 1980s.

Estimates were made of future productivity using various growth projections. These varied between 3 and 20 m³/ha/year, but most species have productivity values around 5–10 m³/ha/year and are less productive than some of the more productive eucalypt or acacia species used in Vietnam. It may be possible to significantly increase these growth rates because a number of soil nutrient deficiencies exist across the region, most especially phosphorus.

Trials suggest all trees (native and exotic) are also inhibited by the acid pH values of the soils being used for plantation establishment.

A survey of 90 small rural sawmills found most were finding it difficult to get sawlogs and that the prices of logs had increased substantially over the previous three years. There are substantial differences in the prices of logs of different species with most of the native species attracting substantially higher prices than the faster-growing exotic species. The biggest price increases had occurred in timbers of the higher-value species. Highest prices were found in districts with the best road networks. However, it is clear from the farmer survey that few farmers are aware of these prices and the market opportunities they represent.

A list of priority species for further silvicultural research was developed based on farmers' preferences, species (current) growth rates and the market prices provided by rural sawmillers. These included *Erythrophloeum fordii*, *Michelia mediocris*, *Chukrasia tabularis*, *Canarium album* and *Cinamomum cassia*. Attempts were made to define site preferences for these species but these were inconclusive in part because of insufficient knowledge of soils and climatic conditions across the region and also because of the patchy distribution of plantations of these species.

Ten different silvicultural systems were developed to incorporate these species in plantations that might suit a range of different economic and ecological situations. These plantations involved fast- (e.g. *Acacia*, *Eucalyptus*) and slow-growing species as well as timber and multi-purpose species. Some were monocultures and others were mixtures.

Financial analyses of each of these model systems were carried out using data on timber prices from the sawmill survey and estimates of the productivity of different species from the plantation survey. Perhaps not surprisingly, the highest NPV and rates of return were obtained with the fast-growing exotic species grown on successive short rotations. The higher productivity of these overcame the advantages of higher timber prices for the native species.

Seven experimental plantings were established at four sites to test some of the principles upon which the 10 model silvicultural systems were based. The plantings enabled the scientists to explore species-site relationships, test various species mixtures and examine the differential competitive abilities of some of the key plantation species. Though still comparatively young they have already provided evidence of the performance of different species under carefully prescribed and well-managed conditions (including which species not to plant at certain sites).

None of the mixtures have so far shown greater (or lesser) productivity than the monocultures. However, there is evidence of a financially attractive mixture involving a short rotation of *Eucalyptus urophylla* grown with a longer rotation of *Michelia mediocris*. The same mixture appears to also improve the stem form of the *Michelia*. The fifth study site on the central coast investigated the performance of native trees established with the assistance of an acacia overstorey or nurse tree. Studies showed that the acacia was initially needed to facilitate the establishment of the several native species, but growth was inhibited if the overstorey lasted beyond seven years.

CONCLUDED PROJECTS

The project has had several sets of impacts. Firstly there has been an impact at the community level with a large number of local farmers visiting the project's field experiments. The Phu Tho provincial TV station made a film about one trial including the *Eucalyptus*–*Michelia* mixture. This resulted in an increased demand on *Michelia* seed throughout the province and a rise in the price of seedlings as growers have sought to replicate it.

Secondly, a number of government agencies involved in reforestation have indicated they plan to use some of these methodologies. The Director of Tam Dao National Park is also proposing to use some of the project designs in the 600 ha forest restoration program being carried out within the Park over the next few years.

A third impact has been at a scientific level. The project has made a special effort to invite scientific colleagues from government bodies such as the Forest Sector Support Program and the Forest Science Institute of Vietnam as well as from Universities, international NGOs and other overseas aid groups to each of its three conferences. The project team have subsequently been asked to provide advice on our methods and results to many of those attending.

Following the final conference in 2006 the Director of Science and Technology at the Ministry of Agriculture and Rural Development (MARD) and the Director of the Forest Science Institute of Vietnam sought assistance in designing a program of work to extend the research undertaken by the project and replicate it more widely.

Finally the project has had an impact on postgraduate student training. A student from Xuan Mai Forestry University has undertaken an MSc study at one of the project's experimental trials. Four undergraduate students have also undertaken project research at the same site under the supervision of Dr Huynh Duc Nhan. Two Vietnamese researchers associated with the project were successful in winning scholarships to study in Australia.

Similar research has been undertaken in Australia in collaboration with the Rainforest CRC. This work has documented the growth of a number of high-value rainforest species across sites in the wet tropics of north Queensland. Studies on the designs of mixed species plantations were undertaken, together with an investigation of the functional role of tree diversity. These studies suggested guidelines for identifying complementary species that might be used in plantation mixes.

FST/2007/025: Socio-economic factors influencing smallholder production of acacia sawlogs in Vietnam

Bilateral

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Four Scenes Pty Ltd, Australia
Project Leader	Dr Michael Blyth
	Phone: 02 6161 0544, 0419 818410
	Fax: 02 6161 0544
	Email: michael.blyth@fourszenes.com.au
Project Budget	\$29,540
Project Duration	01/04/2007 to 30/06/2007
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Tropical acacias are major fast-growing hardwood species used in plantation forestry programs throughout Asia and the Pacific. Although they have the potential to grow under a range of soil conditions, including in areas with a pronounced dry season, their productivity is very dependent on matching the genetic material with the site and proper stand management.

The Government of Vietnam is promoting an ambitious 5 Million Hectare Reforestation Program (5MHRP) which includes the creation of about 3 million ha of tree plantations by 2010. This expanding plantation estate now includes between 300 and 400,000 ha of *Acacia* species. About 150,000 ha are of the *Acacia* hybrid developed by the Forest Science Institute of Vietnam (FSIV). This is the most planted 'species' in Vietnam, with a current planting rate of around 50,000 ha/year.

To date most Vietnamese-grown plantation wood has been sold into the pulpwood market because the plantations are not managed sufficiently to produce high-value sawlogs. The rapidly expanding furniture industry has had to source its timber resources from overseas, resulting in a lost opportunity for investment into the rural areas of Vietnam. Appropriate improvements to silviculture could boost the quality and productivity of the Vietnamese *Acacia* estate, thus producing more sawlogs from these plantations, providing higher returns to growers as well as the benefits of downstream processing.

Presently the supply of wood for downstream processing is primarily from small-scale plantations that form a significant part of the rural economy. The industry is heavily reliant on small landholdings that are ideally suited to the more intensive management required for high-value wood products.

Labour availability in rural areas for value-adding industries is high. In order to accurately focus a potential project on improving sawlog silviculture, ACIAR is commissioning this small research activity to characterise smallholder involvement in the growing of acacia in Vietnam, and to identify and evaluate socio-economic factors that will influence farmer decisions to turn from pulpwood to sawlogs.

Project Outcome

The objective of this project was to identify and evaluate socio-economic factors that may influence decisions by Vietnamese farmers to grow and/or market acacia species for the sawn timber market. The study found that the main factors attracting growers to supply sawlogs were: the prospect of achieving higher income levels; the ability to access markets for sawnwood (distance to sawmills); the quantity and quality of knowledge and technology available for efficient sawlog production. Growers also identified the importance of cash flow and access to loan funds for terms commensurate with a sawlog rotation length.

Those growers interviewed who had direct access to technical advice and support understood the importance of selecting quality certified seedlings of the right species for the site, modifying planting densities and varying silviculture regimes for the production of quality sawlogs. These growers were thinning stands and pruning trees to maximise sawlog yield and wood quality. Furthermore, they were generating cash flow during the rotation.

In provinces visited where growers did not have access to knowledge or technical services, sawlog production was more opportunistic. Thinning and pruning were not practised, with very little plantation management between establishment and harvesting.

These growers associated sawlog production with rotations of 20 or more years. They were unaware of the need for or the benefits of silvicultural interventions. Their resistance to growing sawlogs was influenced also by the perceived lack of cash flow, the long time interval to final harvest and the lack of long-term investment capital. These growers indicated that they would be encouraged to grow acacia for sawlogs if they could access loans commensurate with the sawlog rotation length and if they could gain access to tree and plantation silviculture advice and assistance. They were aware of the higher prices for sawlogs and were sorting and selecting larger logs for sale as sawlogs.

A number of other factors influencing sawlog production decisions were identified in interviews with growers, government officials, traders, researchers and wood processors in Vietnam and from a review of relevant literature. The project also identified the financial benefits for smallholders of a formal relationship with a larger, more influential organisation such as a State Forest Enterprise or government research centre.

Financial analyses conducted for typical smallholders in north, central and south Vietnam revealed the relative economic advantages of sawlog production over pulp log production. The analyses used physical and financial data collected from growers, government organisations and previous studies to model alternative production options. These results assume that growers are able to access and apply appropriate knowledge and have ready access to sawlog buyers and/or processors.

While this study has demonstrated economic advantages of sawlog production, decisions by individual growers are influenced by a range of factors and conditions which vary throughout plantation growing areas of Vietnam. Access to appropriate technical advice and assistance for plantation establishment and management is a critical need. Investment in research and development in the form of species selection, plantation establishment and silviculture trials is needed. This should be supported by participative action research, demonstration sites, training programs for growers, researchers and extension officers and preparation and dissemination of suitable extension materials.

While the focus of this research is on improving livelihoods for smallholders, given the existence of associations between smallholders and larger SFEs or Forestry Companies in many areas, these organisations should be actively involved in research activities. Research and extension efforts need to be sustained with support from provincial and national governments. Projects should be initiated in regions with good potential for sustaining profitable sawlog production from acacia species and where plantation forestry is a key land use option for improving livelihoods.

There is also scope to explore through research some of the factors limiting sawlog production including the influence of road conditions and transport distance in defining economic zones for sawlog production relative to location of sawmills and other processing facilities, the effectiveness of forestry extension services, the feasibility of developing special loan packages for sawlog enterprises, the development of independent market intelligence services and the capacity of existing sawmills to handle increases in wood supplies.

8 ACIAR Publications

This is a list of ACIAR publications produced in 2006-07. Print copies are available by emailing comms@aciar.gov.au, or electronic versions may be downloaded from ACIAR's website www.aciar.gov.au.

Monographs	
119a	Guidelines for surveillance for plant pests in Asia and the Pacific [Indonesian translation]. Teresa McMaugh, Indonesian translation by Andi Trisyono, 2007, 192 pp.
123a	Agricultural development and land policy in Vietnam [Vietnamese translation]. Sally P. Marsh, T. Gordon MacAuley and Pham Van Hung (eds), Vietnamese translation by Pham Van Hung, 2007, 272 pp.
124	Economically important sharks and rays of Indonesia. W.T. White, P.R. Last, J.D. Stevens, G.K. Yearsley, Fahmi and Dharmadi, 2006, 330 pp.
125	Aquaculture in Papua New Guinea: status of freshwater fish farming. Paul T. Smith (ed.), 2007, 123 pp.
126	Agricultural development and land policy in Vietnam: policy briefs. Sally P. Marsh, T. Gordon MacAulay and Pham Van Hung (eds), Vietnamese translation by P.V. Hung, 2007, 72 pp.
127	Postlarval fish capture and grow-out. Cathy Hair, Regon Warren, Ambo Tewaki and Ronnie Posalo, illustrated by Kisi Mae, 2007, 32 pp.

Proceedings	
122	Improving yield and economic viability of peanut production in Papua New Guinea and Australia. Rao C.N. Rachaputi, Graeme Wright, Lastus Kuniata and A. Ranakrishna (eds), 2006, 118 pp.
124	Heart rot and root rot in tropical Acacia plantations. Karina Potter, Anto Rimbawanto and Chris Beadle (eds), 2006, 92 pp.
125	Coconut revival: new possibilities for the 'tree of life'. S.W. Adkins, M. Foale and Y.M.S. Samosir (eds), 2006, 104 pp.

Technical Reports	
64	Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. Stephen Midgley, Michael Blyth, Khamphone Mounlamai, Dao Midgley and Alan Brown, 2007, 96 pp.
65	A review of animal health research opportunities in Nusa Tenggara Timur and Nusa Tenggara Barat provinces, eastern Indonesia. Bruce M. Christie, 2007, 76 pp.
66	Modelling minimum residue thresholds for soil conservation benefits in tropical, semi-arid cropping systems. M.E. Probert, 2007, 36 pp.

Working Papers	
62	Report on a review of ACIAR-funded projects on Rhizobium during 1983–2004. David F. Herridge, 2006, 48 pp.
63	Economics and market analysis of the live reef-fish trade in the Asia–Pacific region. Brian Johnston (ed.), 2007, 172 pp.

Impact Assessment Series Reports	
44	Impact assessment of capacity building and training: assessment framework and two case studies. Jenny Gordon and Kevin Chadwick, 2007, 120 pp.
45	Development of sustainable forestry plantations in China: a review. John W. Turnbull, 2007, 78 pp.
46	Mite pests of honey bees in the Asia–Pacific region. Michael Monck and David Pearce, 2007, 32 pp.
47	Improved Australian tree species for Vietnam. Hayden Fisher and Jenny Gordon, 2007, 36 pp.
48	Assessment of capacity building: overcoming production constraints to sorghum in rainfed environments in India and Australia. Chloe Longmore, M. Cynthia Bantilan and Jenny Gordon, 2007, 44 pp.
49	Minimising impacts of fungal disease of eucalypts in South-East Asia. Hayden Fisher and Jenny Gordon, 2007, 36 pp.
50	Improved trade in mangoes from the Philippines, Thailand and Australia. Michael Monck and David Pearce, 2007, 48 pp.
51	Growing trees on salt-affected land. James Corbishley and David Pearce, 2007, 44 pp.

Corporate publications	
	ACIAR Annual Report 2005–06. October 2006
	ACIAR Annual Operational Plan 2007–08. June 2007
	Adoption of ACIAR project outputs: studies of projects completed in 2002–2003. J. Gordon and J. Davis (eds), 2007, 64 pp.
	ACIAR Publications Catalogue 2007
	Partners in Research for Development magazine Winter 2006 Spring 2006 March–June 2007 July–October 2007
	More crop per drop from Australian International Research (Report on how Australian benefits from ACIAR water research)

www.aciar.gov.au

ACIAR is an Australian Government Statutory Authority that operates within the portfolio of Foreign Affairs and Trade. ACIAR aims to enhance rural household incomes and broader economic growth by investing in international research partnerships that encourage agricultural development, sustainable use of natural resources and capacity-building of benefit to partner countries and Australia.

ACIAR • GPO Box 1571, Canberra ACT 2617

Tel: +61 2 6217 0500 • Fax: +61 2 6217 0501

Email: aciarc@aciarc.gov.au