

Country Profile

Vietnam

November 2006

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

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Preface

The ACIAR Country Profiles are designed as a snapshot of the collaborative research being carried out between Australia and our key partner countries and regions. This publication contains short summaries of both bilateral and multilateral projects involving Vietnam that were active at 30 June 2006. At that time there were 28 active bilateral projects and two active multilateral projects, the latter being led by international agricultural research centres. There were another 23 projects under development, many of which are expected to commence in 2006–07 financial year.

This publication also sets out the key outputs and outcomes from nine bilateral projects and one multilateral that have been completed since 30 June 2006.

In addition to these project summaries, the publication provides a record of the consultations that were held between ACIAR and Vietnam in February 2004 on the medium-term priorities for the joint program, an extract from our 2005–06 Annual Report covering Vietnam, and our near-term program as set out in the 2006–07 Annual Operational Plan.

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

We hope you find the publication useful as a record of the ongoing progress and achievements of ACIAR's collaborative agricultural research and development program with Vietnam. For information on ACIAR's overall program, our website at www.aciar.gov.au is a key gateway to our operations.



Peter Core
Director

November 2006



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Vietnam report 2005–06

(extract from ACIAR Annual Report 2005–06)

Active projects in 2005–06	44
AOP budgeted expenditure in 2005–06	\$3,042,000
Actual bilateral country expenditure in 2005–06	\$2,818,648
Bilateral country expenditure in 2004–05	\$2,983,069
Bilateral country expenditure in 2003–04	\$2,069,638

Key performance indicators	Performance 2005–06
<ul style="list-style-type: none"> Linkages between ACIAR-funded research and AusAID-funded development established in at least four Collaboration for Agriculture and Rural Development (CARD) projects 	Seven CARD projects approved in the 2005 round directly build on current (or recent) ACIAR projects—project 002 (<i>aquaculture</i>), 013 (<i>cocoa</i>), 014 (<i>mud crabs</i>), 025 (<i>agricultural economics capacity building</i>), 016 (<i>rice postharvest technology</i>), 029 (<i>weaver ants</i>) and 032 (<i>acacia plantations</i>).
<ul style="list-style-type: none"> More efficient project approval procedures negotiated with Vietnamese partners 	New approval processes have been successfully negotiated with our Vietnamese partners. However, they have not yet been tested in practice
<ul style="list-style-type: none"> NGO linkages established in at least one additional project 	ACIAR is providing additional support to the World Vision Area Development Plan in Dong Giang District (Quang Nam Province) to improve the capacity of extension staff and local people in applying suitable technologies to improve cattle productivity.
<ul style="list-style-type: none"> Initial trials on low-cost pig feeds completed 	Project schedule required revision to take account of the serious illness of the Australian project leader and the diversion of the Vietnamese personnel to support work on the avian influenza outbreak.
<ul style="list-style-type: none"> Acceptance by government standards agencies of recommendations on maximum concentrations of key heavy metals in soils and crops 	Government agencies in Vietnam (through formal decree) have incorporated the project's standards for maximum concentrations of key heavy metals in both soils and plants.
<ul style="list-style-type: none"> Trials on appropriate aquaculture species combinations for production in reservoirs completed and outcomes from the economics and fisheries technical projects shared 	Knowledge of the best-practice approach to culture-based fisheries in Vietnam, including optimal harvesting strategies and marketing chains to assist farmers to obtain the maximum returns have been developed and actively disseminated to other provinces in North Vietnam, through workshops aimed at farming communities. The Government of Vietnam adopted a new policy which includes incorporation of reservoir fisheries as a strategy to increase food production and income levels of fishers and farmers. They also increased research funding for reservoir fisheries. Linkage and sharing across the technical and economics projects are effective and ongoing.
<ul style="list-style-type: none"> Market information systems established for at least one commodity 	The market information systems for three fruits (plum, longan, chayote) were analysed in detail and information systems established through the Government of Vietnam Centre for Information and Policy Studies in Agricultural R&D.

<ul style="list-style-type: none"> 40% of new projects designed to have significant farmer or policy-maker impacts within 5 years of completion 	<p>Two new projects out of five have been deemed to have this category of impacts: AH/2004/040 <i>The epidemiology, pathogenesis and control of highly pathogenic avian influenza (HPAI) in ducks</i> and CP/2005/053 <i>Diagnostics manual for crop diseases</i>.</p>
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Position

ACIAR's involvement in Vietnam commenced in 1993, and has led to a significant program. Training remains important, but has moved from a predominant emphasis on capacity-building to focus on 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 and non-chemical rodent control in rice crops. Other developments include planting of fast-growing acacias, introduction of improved leucaena as animal fodder, better irrigation management, improved soil fertility management and better control of citrus pests. While most of ACIAR's program has historically been based in greater Ho Chi Minh City or Hanoi (due to the location of research institutes and policy-makers and the national relevance of much of the portfolio), the 2004 country consultation agreed to increase emphasis towards central Vietnam, particularly central coastal regions. Significant effort has therefore gone into establishing new projects both in the central highlands and lowlands.

ACIAR is encouraging greater involvement of the private sector and NGOs in projects, linkages with other R&D activities and donors, and development of closer ties with Vietnamese research and extension organisations. It is already working well with AusAID-funded programs (Collaboration for Agriculture and Rural Development (CARD) and the Quang Ngai Rural Development program).

Achievements

ACIAR has paid particular attention to **agricultural policy development** in Vietnam. One project aimed to develop economic models suitable for analysing agricultural policy reforms to enable assessment of the impacts of alternative agricultural policies. Training and capacity-building have been a major focus of the project, and have provided many academics and government officials with new perspectives on quantitative policy analysis, enhanced computer skills and upgraded analytical capacities. A substantial amount of the training course material on quantitative policy analysis was translated into Vietnamese. A monograph on agricultural development and land policy has been produced by ACIAR and is being translated into Vietnamese.

Animal health has been an ongoing focus in Southeast Asia. In the past year there has been mounting concern about the outbreaks of **avian influenza** in the region, and ACIAR has responded to this with a new project involving both Vietnam and Indonesia. Control of the disease in poultry is hampered by the lack of understanding of ducks as transmitters of the virus to chickens and to humans, and a newly commissioned project aims to determine the epidemiological and transmission characteristics for avian flu virus in intensive and smallholder duck production systems. Project results will aid the development of national vaccination campaigns in both countries.

ACIAR-supported research on **reservoir fishery** development and management in Vietnam's northern mid-highland region has led to further research on farmer-managed reservoirs, seeking to develop the best management practices. Researchers have undertaken a comparison to determine the economics of raising fish fry to fingerlings in cages versus ponds, and also surveyed four reservoirs to determine whether there are previously unrecognised fish species suitable for culture. The most significant outcome is a policy adoption by the Government of Vietnam, which includes the incorporation of reservoir fisheries as a strategy to increase fish food production and increase income levels of fishers and farmers. Authorities plan to lift reservoir production from the current 20,000 tonnes to around 250,000 tonnes by 2010.

Significant progress was made in collecting data on the supply, cost and variability in a range of **raw materials for feeding fish** in northern and southern Vietnam and Cambodia. Similar surveys have also been completed on the nature of *Pangasius* catfish farming practices in each of the regions. In addition to this, methods for determining the nutritional value of a range of raw materials when fed to catfish have now been developed. This included a focus on the assessment of the nutritional value of rice bran and the local bait-fish supplies. Studies have been completed in both northern and southern Vietnam on the determination of energy demand by the catfish. This will be used in the coming year to complete a bio-energetic model that will enable prediction of feed design and feed management strategies for the fast-growing catfish industry.

The small **temperate fruit industry** in the northern Vietnamese uplands is being helped to lift its productivity and profitability through improved postharvest fruit handling and effective disease controls. Researchers are identifying postharvest disease problems associated with production and distribution practices while improving the knowledge and skills of orchardists. See the adjacent box for the full story. Funding from ACIAR has helped the development of a highly successful **fruit fly control** technology, using spent brewery waste as an attractant. Foster's Vietnam is a collaborating partner in the commercialisation of this product, along with a Vietnamese pesticide distribution company. A partnership agreement was formalised in May 2006 at Foster's Tien Giang Brewery. The brewery will provide 50,000 litres of protein bait each year which, diluted with water and with the addition of a tiny amount of insecticide, can increase farmer yields of undamaged fruit by 400 per cent.

In both Vietnam and Thailand, treatment of orchards with **weaver ants** along with application of environmentally friendly soft chemicals (WPS) gave similar or higher yield and quality of fruit to those where chemical insecticides were used. Although weaver ants have a mutual relationship with scales and mealy bugs, soft chemicals (safe for weaver ants) such as white oil and neem oil were effective in reducing the populations of these pests. To stabilise weaver ant populations in mango orchards, it was essential to isolate the ant colonies, transplant colonies with queens and mix mango trees with other tree crops such as citrus. If mango orchards are monocultured, extra ant food must be provided when trees are in dormancy. Two types of integrated pest management, for both organic and conventional growers, have been successfully developed for mango growers in Vietnam, Thailand and Australia.

In a study of **upland soils**, researchers have determined that in some instances greater productivity can be attained by increasing the soil water-holding capacity rather than by supplying extra nutrients. They also concluded that soil management regimes may need to be tailored to different soil types. Detection of soils with minimal surface charge, similar to some in tropical Australia, presents a challenge to nutrient management because they do not retain cation and anion nutrients for plant growth.

There are many contaminants in agricultural inputs such as fertilisers, manures, composts and pesticides. In Vietnam laboratory facilities at the University of Agriculture and Forestry have been updated for the study of **soil and crop contamination**, with help from Australian laboratory staff. The project now has a database of background concentrations of toxic metals in Vietnamese agricultural soils and identified critical concentrations of heavy metals and metalloids in subtropical and tropical soils with regard to toxicity and transfers in the food chain. These new scientific criteria and guidelines will help to rank wastes as suitable or unsuitable for use in peri-urban agricultural systems.

In the search for more profitable **beef production** a project is linking with the AusAID Quang Ngai Rural Development Program to provide better feeding options for cattle owned by farmers associated with the program. Researchers have assembled information on the availability and quality of local feeds and are now commencing animal house experiments. The project includes social science studies being undertaken by Hue University.

ACIAR has had a long-term commitment to improving the value of **plantation-grown eucalypts** in Vietnam and elsewhere. Problems such as splitting of logs during processing, which limit their use as sawn timber, are being addressed through two new projects. The first aims for improvements through better genetic selection and silvicultural practices; the second seeks a better product through changes in the sawing and drying processes.

Vietnam is a beneficiary of long-term ACIAR-funded research into **clonal propagation of coconuts**. At the Oil Plant Institute (OPI) the success rate of acclimatisation of coconut plantlets in the nursery is an impressive 80 per cent and the survival rate on the field is 100 per cent of the planted seedlings (previously it was zero). From this dramatically improved situation 1.4 hectares of Makapuno and aromatic seedlings, derived through embryo culture, have now been established in the field at OPI's Trang Bang Station, and there are sufficient embryo-derived seedlings to enlarge this field planting area to 4.5 hectares. These plantings will form the basis of supply to farmers, helping to greatly lift their farm productivity.

Orchards at Lao Cai increase their harvest

'Of course I will get fewer plums when I participate in the project and let them cut my trees, but I agreed because I hope that it will improve their quality,' said Sen Van Cuong, a member of the Nung ethnic minority in Bac Ha district of Vietnam's Lao Cai Province. Cuong and his family are participating in an ACIAR-funded project involving the Ministry of Agriculture and Rural Development (MARD), NSW Department of Primary Industries and Qld Department of Primary Industries and Fisheries.

The region is known for its *Tam Hoa* plums. The farmers are learning that they can improve the productivity and profitability of their trees by radically changing how they are pruned and managed. Heavily pruned trees quickly regenerate to produce fresh, young fruiting wood, which in turn reduces numbers of fruit produced per tree and results in larger fruit of better quality. Previously, these trees produced 30–40 small, low value plums per kg; as a result of this project, in the future, the trees should produce about 15–20 large, high value plums per kg. Another project objective is to establish orchards that showcase newly introduced cultivars and demonstrate the benefits of pruning, pest control, fertiliser use and irrigation. After observing results in demonstration trials the farmers are willing to try the new methods.

'This project is training farmers to grow trees that yield at different times so the farmers can harvest plums in different seasons,' says Dang Vu Thi Thanh of MARD's National Institute of Plant Protection. 'In the past farmers had to tolerate low prices because their fruit ripened all at once, and had to be sold when prices were low. When farmers sell in the main season they receive only about VND500–1000, but if their fruit can ripen two weeks later they can receive up to VND4000 per kg.'

The orchard farmers in Bac Ha district are being taught to prune their trees, to apply the fertiliser and water them at the right time in order to improve the quality of the plums. About 2000 households stand to benefit from these improvements. To assist the industry, the Lao Cai Province is planning to set up processing facilities, including a cannery.

Vietnam plan 2006–07

(extract from ACIAR Annual Operational Plan 2006–07)

GNI per capita ¹		Bilateral actual 2004–05	\$2.90 m
Population ²	84.2 million	Bilateral forecast 2005–06	\$3.04 m
Population 2015/2050 ³	95/116.7 million	Bilateral budget 2006–07	\$3.14 m
Active bilateral projects	25	Bilateral + multilateral	
Active multilateral projects	1	budget 2006–07	\$3.39 m

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.

Key performance indicators (2006–07)

- Linkages between ACIAR-funded research and AusAID-funded development continues to be maintained in at least four CARD projects
- Surveillance and diagnostic systems and manuals developed for plant pest and diseases
- Adoption of fruit fly management technology and commercialisation of protein baits in north and south Vietnam
- Increased emphasis on animal health and biosecurity issues commensurate with the rising concern of Avian Influenza and Vietnam as an Asian epicentre
- Continued emphasis in aquaculture and fisheries with new projects on shrimps and oysters initiated.
- 40 per cent of new projects designed to have significant farmer or policymaker impacts within five years of completion

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.

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

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

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

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.

During 2006–07 new project opportunities will be explored in selected areas of agricultural development policy and economic analysis, animal sciences and fisheries. However, a number of current projects across all program areas have been extended in order to increase the uptake of results by farmers and also incorporate them in the policy process.

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.

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*. As demand for new projects consistently exceeds available funds, it is expected that ACIAR will only support a limited number of projects within the agreed areas of cooperation.

The delivery of most ACIAR-supported informal and postgraduate research degree training will continue 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; collection and analysis of market information.

Indicative priorities are grouped under the following programmatic themes:

Better policy interventions for meeting market specifications and opportunities

- Options for development of small-scale agro-enterprises in rural areas
- Assessment of impacts of trade agreements, including sanitary and phytosanitary standards and market access
- Policy options for cooperatives in agricultural and fisheries production for optimising market-oriented crop production to deliver improved returns to smallholders
- Policy and technical research to complement other donor interventions on highly pathogenic avian influenza and other zoonotic diseases

Enhanced quality and reduced losses in crops and forest products

- Enhancement of diagnosis, surveillance and management of pests of perennial crops of central Vietnam
- Integration of fruit fly control strategies with the management of other insect pests
- Reducing postharvest losses and ensuring quality in smallholder systems for fruit, grains, legumes, animal feed and coffee
- Interventions to enhance the safety and marketability of tropical fruit
- Improvement of plantation wood processing efficiency through small-scale sawing, drying, preservation, and use of composites

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, with particular attention to shrimp health
- Smallholder pig production systems including nutrition, housing, health and marketing
- Smallholder production of ruminants within crop–livestock systems, including nutrition, genotype assessment and management
- Incentives and regulatory issues for improved animal waste management in peri-urban areas

Optimising water and soil management for sustainable production, particularly on degraded lands

- 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 cultivation techniques, including recycling of organic matter including crop residues and green manures, to develop agriculture and agroforestry on poor sandy soils in central coastal Vietnam
- Development of land-use practices to minimise the negative impacts to the environment on sandy and acid sulfate areas
- Application of water-saving technology and nutrient management systems in production of rice and other crops

Key program managers

Dr Ray Trewin, Agricultural Development Policy

Dr TK Lim, Crop Protection

Mr Barney Smith, Fisheries

Dr Russell Haines, Forestry

Dr Ian Willett, Land and Water Resources

Dr Bill Winter, Livestock Production Systems

Country Manager

Ms Misha Coleman, ACIAR Country Manager, Vietnam

Active projects

at 30 June 2006

Bilateral

ADP/2000/018	The economics of developing reservoir aquaculture in Vietnam	17
ADP/2001/066	Strengthening agricultural market information activities in Vietnam	20
ADP/2002/015	Managing groundwater access in Tay Nguyen (Central Highlands) Vietnam	22
AH/2004/040	The epidemiology, pathogenesis and control of highly pathogenic avian influenza (HPAI) in ducks in Indonesia and Vietnam	24
CP/1998/005	Managing pest fruit flies to increase production of fruit and vegetable crops in Vietnam	26
CP/2000/043	Huanglongbing management for Indonesia, Vietnam and Australia	28
CP/2001/027	Adaptation of low-chill temperate fruits to Australia, Thailand, Laos and Vietnam	30
CP/2002/086	Improving postharvest quality of temperate fruits in Vietnam and Australia	32
CP/2002/115	Diseases of crops in the central provinces of Vietnam: diagnosis, extension and control	34
CP/2005/053	Plant disease diagnostic manual	36
FIS/2000/065	Assessing the potential for low cost formulated diets for mud crab aquaculture in Australia, Indonesia and Vietnam	37
FIS/2001/058	Sustainable tropical spiny lobster aquaculture in Vietnam and Australia	39
FIS/2002/068	Improving feeds and feeding for small scale aquaculture in Vietnam and Cambodia	42
FIS/2002/077	Improved hatchery and growout technology for marine finfish in the Asia-Pacific region	44
FIS/2003/003	Stock structure of two important Mekong River carp species (<i>Henicorynchus</i> spp.)	46
FST/1999/095	Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: Genetics and silviculture	48
FST/2000/003	Mixed species plantations of high-value trees for timber production and enhanced community services in Vietnam and Australia	50
FST/2001/021	Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying	53
FST/2002/112	Domestication of Meliaceae species in Southeast Asia and Australia, particularly management of the problem of <i>Hypsipyla robusta</i> attack	55
FST/2003/002	Development and evaluation of sterile triploids and polyploid breeding methodologies for commercial species of <i>Acacia</i> in Vietnam, South Africa and Australia	57
LPS/2002/078	Improved beef production in central Vietnam	59

LPS/2002/079	Utilisation of local ingredients in commercial feeds for pigs	61
LPS/2004/073	Capacity building on cattle production at Dong Giang district, Quang Nam province, Vietnam	63
LWR/2002/073	Efficient nutrient use in rice production in Vietnam achieved using inoculant biofertilisers	65
LWR/2002/085	Utilising basic soil data for the sustainable management of upland soils in Vietnam and Australia	67
PLIA/2000/165	Facilitating farmer uptake of ACIAR project results: World Vision collaborative program	69
PLIA/2002/103	Enhancing project impact and science capability through ongoing evaluation	71
SFS/2003/060	Implementation of rodent management in intensive irrigated rice production systems in Indonesia and Vietnam	73
Multilateral		
AH/1998/054	Poverty alleviation and food security through improving the sweet potato-pig systems in Indonesia and Vietnam	74
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	76

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

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	University of Agriculture and Forestry, 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 31/12/2006 (Project extended from 01/07/2005 to 31/12/2006)
ACIAR Research Program Manager	Dr Ray Trewin

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 to help farmers/fishers better manage their aquaculture systems.

Project progress**Year 3 (01/01/2005–31/12/2005)**

Progress on Objective 1: Two aspects are involved, surveys and model building.

Surveys in two phases were planned to collect data. The first phase was completed in 2004 and has provided data on the extent of *variability* in input and output factors, as well as in fish farming system characteristics, such as purchasing or production of fingerlings, fish feeding if any, and harvesting techniques. The second phase started in September 2004 and aimed at understanding the day-to-day *dynamics* over time, and to collect the necessary data to calibrate a bioeconomic model for different aquaculture systems (see below). Surveys focused on two types of fish for market operations: cage culture and farmer-managed reservoirs; production of fingerlings was also included. The second phase surveys were held, as for the first phase, both in the north (Yen Bai and Thai Nguyen provinces) and in the south (Dong Nai and Binh Phuoc provinces). Surveys and case studies have yielded much raw data which, further analysed, should yield useful understanding of the constraints to and potential of aquaculture development in the country. Recent government decisions to ban cove culture and restrict cage culture in large reservoirs mean that investigations have been primarily focused on farmer-managed reservoirs, whether in cooperative or household arrangements.

Model building: A first version of “BRAVO”, or **B**ioeconomic model of **R**eservoir **A**quaculture for **V**ietnamese **O**perations, was constructed during 2004 and successfully calibrated to the northern small reservoir systems, based on data provided by the sister project FIS/2001/013. More data are still needed before it can be calibrated to the larger systems of the south. The model has been modified to allow for these larger southern systems, and a fishing ‘effort function’ has now been introduced. BRAVO contains both a multi-species biological module and an economic module. BRAVO is implemented in Excel© so as to make it portable and easily usable by Vietnamese project participants. It is at this stage a simulation model and does not optimise for species mix, stocking rates and harvesting strategies; but we are looking into adding an optimisation module to it. BRAVO was presented, together with some first simulation results, at the First Project Workshop held at Nong Lam University on 8 December 2004, of which a report is available. These results were also presented at the 49th Annual Conference of the Australian Agricultural and Resource Economics Society in February 2005. A second version of BRAVO has included the uncertainty and riskiness of aquaculture outcomes, in particular due to fluctuating prices. A paper summarising this stochastic version was written for the 50th Annual AARES conference in February 2006. Currently, the model is being developed along two lines. First, we allow for some basic institutional aspects by differentiating between two (later several) money flows into and out of the aquaculture system; cooperative and individual finances can thus be distinguished. Secondly, we are trying, data permitting, to include the economics of fish feeding into the effort function, along with stocking and harvesting effort.

Progress on Objective 2:

Surveys of marketing systems follow the same pattern as for production. The first phase was completed in 2004, yielding the result that marketing conditions, like production, vary widely in the sample, reflecting the early learning stages of this nascent industry. The second phase of surveys began in September 2004, both in the south and in the north, and targeted so-called ‘middlemen’ or tradespeople, often women, who sell fingerlings and adult market fish to wholesalers and retailers. A number of local informers/surveyors were hired for a day-to-day follow-up of fish marketing transactions, with species, quantities, prices and other marketing characteristics being recorded over 14 months, starting in January 2005. The data have now been collected and entered in a data base, and are yielding insights into the dynamics of price fluctuations and into differences between prices paid to fishers and prices paid by consumers. This part of the project has been complemented by an extension to the sister project FIS/2001/013 which included detailed fish market analysis in the north over one harvesting season.

A ‘business plan template’ had initially been designed with the triple goal of gathering important economic information on the riskiness of aquaculture operations; allowing operators to become aware of their financial strengths and weaknesses; and possibly reducing in the future the cost of official bank loans in terms of collateral, and so the need for exorbitant unofficial loans. The template was designed using current bank loan forms as a starting point, but focused on production and price risks. However, after several field trips, it appeared that the constraints to aquaculture credit were institutional rather than informational, and this tool was deemed by local people to be premature in the current situation. It therefore had to be dropped.

Progress on Objective 3:

Data gathering strategy has paralleled that for production and marketing. The first phase surveys were completed in 2004 and targeted local authorities at the Provincial, District and Village (Commune) levels, as well as the extension services at the Provincial level. Phase two surveys took the form of case studies. They have included input and feedback from local stakeholders, in particular using Project Workshop no. 2 as a platform (see below). Aquaculture cooperative charters have partly been translated and analysed, as well as government regulations impinging on aquaculture (work still ongoing). A Vietnamese Masters student has chosen to work on this data for his thesis at the University of Western Australia.

A workshop was held in two different areas, one in the north, and one in the south. Workshop 1 had had an academic and methodological focus and had been held in English at Nong Lam University, while Workshop 2, both north and south, was stakeholder focused and held in Vietnamese. The purpose of both was to inform project stakeholders of the work done so far and of the interpretation of findings from the surveys, and to obtain feedback from stakeholders regarding project work, its relevance, and the correctness of our interpretation of the data. A third goal was to allow people from different provinces and from different institutional levels the opportunity for questions and answers on relevant topics.

Overall, both workshops confirmed what we had learnt from field studies during the year. However, a certain degree of caution from participants did not allow an open discussion of the more sensitive issues, for example the bidding system for reservoir fishing rights. As expected, identifying the institutional constraints to improved aquaculture development has proven to be the more difficult aspect of the project. On the other hand, much has been learnt about fish marketing networks and price dynamics.

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

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	University of Western Australia, Agricultural and Resource Economics, Australia
Project Leader	Associate Professor Michael Burton Phone: 08 9330 2531 Fax: 08 9330 1098 Email: mpburton@agric.uwa.edu.au
Collaborating Institutions	Ministry of Agriculture and Rural Development, Vietnam Department of Agriculture and Food, Western Australia, Australia
Project Budget	\$399,575
Project Duration	01/01/2003 to 30/06/2007 (Project extended from 01/07/2005 to 30/06/2007)
ACIAR Research Program Manager	Dr Ray Trewin

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 identifying 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 3 (01/01/2005–31/12/2005)

The main activities in the past year focused on training in quantitative analysis, development of modelling capacity and institutional design.

Case studies: Field work on fruit marketing in the northern mountainous regions was completed, data was analysed and a report finalised. A final workshop for this case study was held in Lao Cai on April 21 2006, which was attended by Department of Agriculture and Rural Development scientists, district extensions officers, People’s Committee officials, and several fruit farmers. The findings of the report including the policy recommendations were discussed in an open forum. A key conclusion from the discussion was to give more emphasis to markets when developing local policy, particularly with regard to policies aimed at supporting supply expansion.

International comparison for institutional design: A field trip to Australia was completed, involving visits to several economic policy research institutions, including ABARE, the Productivity Commission, and the Economics Division of the New South Wales Department of Primary Industries, as well as several Universities. In addition, several research funding organisations were visited and a visit to the Sydney Fish markets was undertaken. The trip provided exposure to a number of institutional design concepts that have been reported back to the Ministry through the trip report. Some of the key lessons included detailed insights into the structure and operation of ABARE and its link with policy makers; introduction to the concept of public inquiries into industry performance and public monitoring of government performance at the Productivity Commission; exposure to the farm-level economic advisory services (gross margin budgeting) at the NSW Department of Primary Industries. These

ideas are being incorporated into the design of the new Institute for Policy and Strategy for Agriculture and Rural Development.

Capacity building in modelling: A formal training course on general equilibrium modelling and trade modelling was given by Dr David Vanzetti and Dr Anna Strutt in Hanoi, which was attended by staff at the Institute along with economists from other government research institutes. Three staff visited the University of Western Australia for one month to undertake intensive training on econometrics for demand and supply estimation, with Ass Prof Michael Burton and Dr Greg Hertzler, respectively. These training sessions built on the lecture series given in the previous year. During their visit, Mr Thang and Ms Giang were also worked with Dr Brennan on building a partial equilibrium model of fruit production and marketing for the Lao Cai case study. This was used to demonstrate the need for more emphasis on market potential when setting policies regarding supply expansion.

Mr Thang and Ms Giang visited the Maroochy Research Station in Queensland to discuss research links between the fruit marketing study and the ACIAR postharvest project. Dr Bob Nissen gave a lot of useful advice about plum productions systems that were used in developing hypotheses for econometric analysis conducted by Ms Giang. Ms Quynh Chi commenced work with Dr Donna Brennan on developing a partial equilibrium model of the world coffee sector that took account of differences in varieties.

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

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	Taj 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 Ray Trewin

Project background and objectives

The Tay Nguyen (Central Highlands) region is Vietnam's leading coffee producer. It also supplies agricultural and forestry products for domestic markets and export. The region 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 struck, reducing 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, and
- build the capacity of Vietnamese scientists and organisations involved in resource and environmental management.

Project progress

Year 1 (01/01/2005–31/12/2005)

The pre-existing model of the groundwater resource in Dak Lak Province has been up-dated and up-graded in conjunction with MONRE and DHI International. This has involved the collection of new bio-physical data and the integration of surface water and groundwater flows. The new model has yielded robust predictions of groundwater levels and river flows under different agricultural cropping regimes and is now ready for use as a component in the bio-economic modelling of alternative water extraction scenarios. A presentation of the capacity of the model was provided to officials of MONRE and members of the broader project team in Hanoi in November 2005.

Further components of that modelling have also been developed.

A survey of farmers in the Dak Lak Province to determine their use of water in cropping activities and the economics of those operations has been completed in association with Tay Nguyen University. In person interviews of respondent farmers were carried out by staff members of Tay Nguyen University. Analysis of the data collected is under way.

Work on the Choice Modelling study, designed to estimate the value of water used for domestic purposes in Buon Meh Thout City, has also commenced in conjunction with Ho Chi Minh City Economics University. Some pre-testing of basic approaches to the Choice Modelling questionnaire was carried out in Buon Meh Thout City. The City water supply company has cooperated to facilitate the Choice Modelling study.

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

Overseas Collaborating Countries	Indonesia, Vietnam
Commissioned Organisation	Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease, Australia
Project Leader	Dr Stephen Prowse Phone: 07 3346 8861 Fax: 07 3346 8862 Email: stephen.prowse@abcrc.org.au
Collaborating Institutions	University of Queensland, Australia 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

Starting in 2003, the avian influenza epidemic has spread through poultry flocks of Asia, and it continues. Countries affected include Thailand, Vietnam, Cambodia, Indonesia, China, Laos, Japan, the Republic of Korea, Asiatic and Central Russia. Recent outbreaks have occurred in Turkey and Romania. 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 strain. The outbreaks were unprecedented in their scale and geographic spread, accompanied by 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 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, associated with the scare of contracting the disease. The losses in Asia are estimated at \$US10–15B so far and continuing. Of most concern is the high fatality rate in humans infected through contact with 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 (total ~60 confirmed). 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 many deaths.

It is unclear whether 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, and for how long the virus continues to be shed into the environment.

The project has five major objectives:

- To determine the epidemiological characteristics (e.g. seroprevalence, duration of virus shedding) of HPAI H5N1 virus in smallholder duck production systems in Indonesia and Vietnam.
- To understand the role of ducks as maintenance hosts and amplifiers of H5N1 virus during and after infection.
- To understand the pathogenesis of HPAI H5N1 infection in ducks.
- To evaluate the efficacy of current vaccines in ducks and determine the possible role of vaccination in reducing virus load and shedding in ducks
- To develop recommendations for an epidemiological monitoring system that enables 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 smallholder farms (including vaccinated and unvaccinated flocks) to determine the prevalence of past and present infection with the H5N1 virus. Challenge experiments will involve vaccinated and unvaccinated ducks, using strains of H5N1 virus isolated in Indonesia. These will determine tissue tropism (directional tissue growth in response to the virus), 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

First progress report due in 2007.

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

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Griffith University, Faculty of Environmental Sciences, Australia
Project Leader	Professor Dick Drew Phone: 07 3875 3696, home 07-3379 1554, mobile 0417 729 356 Fax: 07 3875 3697, home 07 3379 1554 Email: D.Drew@griffith.edu.au
Collaborating Institutions	National Institute of Plant Protection, 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 01/05/2006 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 5 (01/07/2005–30/06/2006)

Extensive collections of adult fruit flies obtained from male lure traps and reared from host fruits (cultivated and wild) over 23 provinces covering north, central and south Vietnam have revealed that there are eight species of fruit flies of economic importance to horticultural production and export trade in Vietnam. These are *Bactrocera dorsalis*, *B. carambolae*, *B. correcta*, *B. cucurbitae*, *B. latifrons*, *B. pyrifoliae*, *B. zonata* and *B. tau*. The species causing the greatest damage in north Vietnam are *B. dorsalis*, *B. pyrifoliae* and *B. cucurbitae*, whereas in south Vietnam the species causing greatest damage are *B. dorsalis*, *B. correcta* and *B. cucurbitae*. Crop losses ranging from 40 to 100% were recorded in a wide range of fruits and vegetables with no control measures.

To assist with field control studies and other ACIAR-funded projects to improve postharvest fruit quality, laboratory colonies (rearing on artificial diet) of *B. cucurbitae*, *B. dorsalis* and *B. pyrifoliae* were established at the National Institute of Plant Protection (NIPP). At the Southern Fruits Research Institute (SOFRI) colonies of pest species *B. correcta* and *B. dorsalis* were successfully established. These laboratory colonies provide adult flies for laboratory and field-attractancy testing for ongoing quality control of the new protein bait produced at Foster's Tien Giang brewery.

The protein bait production plant at Foster's Tien Giang was officially launched on 16 April 2004 by the Australian Ambassador to Vietnam, the Hon Joe Thwaites. Senior officials from the Tien Giang provincial government, Ministry of Agriculture and Rural Development (MARD) Vietnam, Fosters Brewing International, Griffith University, Queensland Government, AusAID and ACIAR, as well as over 200 local farmers from the surrounding provinces attended the ceremony. The protein product has been officially registered in Vietnam under the trade name SOFRI Protein 10DDD (yeast protein + fipronil insecticide) and is being made available for sale to farmers through a local pesticide distribution company that has numerous outlets in the Mekong delta. The price has been kept very low and is controlled by a steering committee comprising Griffith University, ACIAR Vietnam, SOFRI, Foster's Tien Giang and Cantho Pesticide Company. The protein production plant at Foster's Tien Giang has an annual production capacity of about 50,000 litres of protein.

The use of SOFRI Protein 10DD both in small farms and over large areas has provided excellent control of pest fruit flies across a range of fruit and fruiting vegetable crops in Vietnam, resulting in major increase in incomes for farmers. For example, H'Mong minority hill tribe people in the northern province of Son La, Moc Chau district cultivate peach as their main crop but have always had to harvest the fruits hard green because ripe fruits are 100 per cent infested by fruit flies. Using the spot spray protein bait technology, fruit fly damage was reduced to less than 5 per cent, resulting in farmers harvesting ripe fruits from which they obtained higher yields and better prices. Overall this resulted in a 4-fold increase in incomes in one season for the peach farmers. Barbados cherry farmers in Go Cong province in the Mekong Delta have also experienced a similar benefit with a 2-fold increase in incomes resulting from higher yields in orchards using SOFRI Protein 10DD. Control trials in other crops like guava, jujube, luffa and bitter melon have reduced fruit fly damage from over 70 per cent to less than 5 per cent. The protein bait spot spray technique also provides major health and environmental benefits by utilising extremely low amounts of pesticide and spray volumes in comparison with cover sprays of insecticides. The Ministry of Agriculture and Rural Development now plans to set up more protein production plants in other breweries across the country and extend the benefits of the protein spot spray bait technology to the wider farming community in Vietnam.

An extensive training program on the biology and control of fruit flies for Provincial Plant Protection Department (PPPD) staff, as well as for farmers has been successfully implemented in various provinces around Vietnam by project staff from Brisbane who trained a core group of trainers from NIPP, SOFRI, PPD and selected Universities in Vietnam. These staff from NIPP and SOFRI have subsequently completed training a total of 290 PPPD and sub-PPPD staff as well as 4445 farmers from 16 provinces across Vietnam. As well over 5000 illustrated brochures in Vietnamese on the biology and management of fruit flies, and the use of the new protein bait spray technology introduced by the project, have been distributed.

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

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 National Institute of Plant Protection, Vietnam Centre de Cooperation Internationale en Recherche Agronomique pour le Development, 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 of the disease entering Australia.

Project progress

Year 3 (01/01/2005–31/12/2005)

During 2005, significant progress was made in overcoming setbacks stemming from the impact of international events in 2003 and ongoing impacts of similar events on travel. The project was reviewed from 6 to 12 November by Prof Myron Zalucki (University of Queensland), Dr Nguyen Cong Thuat (Ministry of Agriculture and Rural Development, Hanoi, Vietnam) and Dr Baharuddin (Hasanuddin University, Makassar, Indonesia).

In southern Vietnam, studies continued at the project field site at Cai Be in Tien Giang in the Mekong Delta where application of mineral oils, pesticides and other management strategies are being compared. Populations of the Asiatic citrus psyllid and the incidence of huanglongbing were low, much lower than anticipated, an outcome seemingly linked to the presence of guava trees interplanted between citrus trees at the site. The implications for control of the vector and the disease will have major repercussions for citrus production throughout Southeast Asia should ongoing sampling and future experiments confirm the observations.

In northern Vietnam at Cao Phong, where a similar experiment to the one at Cai Be (but without guava interplants) is being conducted, growth of trees at the project field site was slower than in the tropical south. Populations of the psyllid were very low throughout the year (three were recorded) and seemingly related to low incidence of psyllid in the local area due to increased use, and more thorough applications, of pesticides in recent years. Infestations of the defoliating gold dust beetle (*Hypomeces squamosus*) were of concern in all treatments, and raised the possibility that high incidence of the weevil could be due to the widespread absence of the once common predatory ant *Oecophylla smaragdina* (golden weaver ant) in northern Vietnam.

In northern Vietnam, limited surveys were undertaken to locate and collect material from endemic *Citrus* spp. and *Citrus* relatives. This work was done in conjunction with placement of an Australian Business Volunteer (Mr Harry Jones) at the National Institute for Plant Protection (NIPP). Prof David Mabberley (University of Washington) visited Hanoi shortly after Mr Jones returned to Australia. During this visit he examined plant material collected by Mr Jones, visited Cuc Phuong National Park 80 km to the west of Hanoi and the Science & Technology Research Institute, and met with Dr Dzuong Duc Huyen (Head of Botany and the local co-ordinator for PROSEA—a largely Dutch initiative linked to the University of Wageningen) with whom he discussed herbarium records in Vietnam.

Experiments on the impact of deposits of 0%, 0.25%, 0.5%, 1% and 2% of aqueous mineral oil emulsions of two mineral oils on oviposition by *Diaphorina citri* were also undertaken in screen-houses at NIPP. Deposits of emulsion with = 0.5% oil reduced oviposition on buds shorter than 6 mm and longer than 10 mm by more than 75%, with effects more evident for the nC24 agricultural mineral oil tested than for the nC21 horticultural mineral oil tested. Mortalities of eggs laid on deposits, and of first instar nymphs that hatched from eggs laid on the deposits, were also significant: total mortality for the two life-cycle stages in treatments with = 0.5% oil exceeded 55%.

In Indonesia, preparation and establishment of all field sites was completed in November. These sites are being used for research on: (a) the impact of altitude (40 m, 670 m and 1300 m asl) on the vector and the disease; (b) the susceptibility of *Citrus* and *Citrus* relatives to the disease (c) studies on natural enemies of the vector; and (d) the impact pest management strategies, including the use of mineral oils and insecticides.

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

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	Research Institute of Fruit and Vegetables, Vietnam National Institute of Plant Protection, Vietnam 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 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 progress

Note: as at October 2006 the Vietnam report component is forthcoming.

Year 5 (01/07/2005–30/06/2006)

Lao PDR

Productivity and economic performance

The high returns from temperate fruits have created a lot of interest in these crops which subsequently has seen these crops promoted for future development. New temperate fruit production systems have been extended to four new districts in Xiengkhouang Province and one new province, Huaphan. A small nursery, which will be used to propagate temperate and other subtropical fruit species, has been established near the Regional Agricultural Office in Ponsavan.

We estimate that farmers at Nonghet, near the Vietnamese border are picking about 10–12 kg of stonefruit per tree with a return of \$A1.50 per kg. At a tree density of 600 trees per hectare this will provide an income of about \$A6000–8000 per hectare, about 20 times their current income of \$300 per annum. Even higher returns could be achieved if farmers adequately thinned their trees and applied some basic management practices.

Improving orchard management

In 2005–06, unseasonable drought severely affected the establishment of some orchard blocks. The new demonstration block of stonefruit, established on the Plain of Jars near Ponsavan, on a commercial farmer's site, suffered severe water stress with a significant loss of trees. Although the region has a plentiful supply of water, which is held in small dams, farmers lack expertise and funding in designing and installing suitable irrigation systems. The project is intending to rectify this problem in 2006–07 by installing a suitable irrigation system for the Plain of Jars site.

Training and communication

Good communication links have now been established between the Thai and Lao research and extension officers. Through their biannual trips to Lao, the Thai researchers have successfully trained the Lao extension officers in temperate fruit technologies. Two training workshops and field days were held in 2005–06, which were both attended by over 20 participants. A group comprising four Lao scientists and one farmer undertook a study tour of low-chill temperate fruit growing region of Queensland and NSW in October 2005.

Thailand

Productivity and economic performance

In Thailand, the DOA has established stonefruit demonstration orchards at four farmer sites in Khun Wang Province and at four sites in Ang Kang Province. Trees vary from 2 to 4 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).

At the ACIAR demonstration block on Royal Ang Kang Research Station, we estimated that trees of peach cv Tropic Beauty carried about 120–150 fruit per tree, with an average fruit weight of 150 g (18–22 kg per tree). Because of the steep slope, and the necessity to use benches, the planting density is low, about 400 trees per hectare. We estimate yields to be about 8 tonnes per hectare. Using an average price of \$A3 per kg, returns of \$23,000 per hectare have been demonstrated.

Improving orchard management

A visit to the World Vision demonstration plots at Ban Kon Pan Village near Chiangrai in northern Thailand showed significant improvements in orchard management and consequently fruit quality. Newly introduced varieties such as peach cv Tropic Beauty had performed well. This variety appears to be well adapted to the region.

Training and communication

An extension methodology workshop was held in Chiangmai Thailand to examine ways of improving delivery of temperate fruit methodologies to farmers. The meeting was attended by farmers, extension agents from the Royal Project Foundation, Highland Project and by the DOA and DOAE. An improved understanding on the best extension methodologies to use to improve the delivery of temperate fruit technologies to Thai farmers was developed.

Marketing

In July 2005, Dr Alan George, Bob Nissen and Mr Uthai Noppakoonwong attended the ISHS International Conference on supply chains. The conference highlighted the lack of understanding of marketing and supply chain management by extension agents and the need to implement quality assurance systems too access export markets.

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

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	NSW Department of Primary Industries, Australia
Project Leader	Dr Shane Hetherington Phone: 02 63913860 Fax: 02 6391 3899 Email: shane.hetherington@agric.nsw.gov.au
Collaborating Institutions	National Institute of Plant Protection, 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 31/12/2008 (Project extended from 01/01/2008 to 31/12/2008)
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 2 (01/07/2005–30/06/2006)

Fruit quality has improved in experimental orchards across three north Vietnamese peach and plum production regions. This improvement is the result of simple management techniques taught to Vietnamese project staff and passed on to Vietnamese farmers. These techniques cost very little to implement. 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. Our initial strategy has been to conduct our experiments on commercial orchards, prove our management techniques under Vietnamese conditions and use the results as extension tools. Despite initial scepticism the advocacy of our orchardist collaborators has now become a powerful extension tool which we intend using during the remainder of the project.

Improved prices for farmers will only continue if the rest of the supply chain can consistently supply the Vietnamese domestic market with high quality fruit. Our work has highlighted shortcomings within the Vietnamese fruit supply chain and is now seeking regionally feasible solutions to these problems. In the past fruit has been harvested 'hard green' largely to endure the rigours of transport and withstand fruit fly infestation and disease infection. Maturity indices have been developed which help farmers to decide when to harvest fruit to maximise quality. We now recommend that fruit be harvested when it is much more mature than previously. Consequently fruit is softer and sweeter at harvest. Pest management and packaging are now more important and our work is aiming to facilitate harvest and transport of high quality fruit. A simple technique for dipping fruit in the fungicides carbendazim and iprodione has consistently reduced losses caused by postharvest disease. Additionally the project team is aiming to reduce postharvest disease by using essential oil fumigants and biological control agents.

Because fruit production regions are between 4 and 10 hours from markets, transport is a problem. Low commercial returns have not justified expenditure on transport systems. Improved fruit quality will have flow-on effects as wholesalers, retailers and consumers demand delivery of produce in good order. Again, our strategy has been to quantify the problems and then test possible solutions experimentally. Three strategies (fruit conditioning, improved packaging and refrigeration) are being experimentally tested. Fruit conditioning has proven successful in Australia both experimentally and following its recent commercial introduction. ReTain, a commercial formulation of aminoethoxyvinylglycine (AVG), may be a useful tool enabling growers to harvest their fruit later when it is larger, more highly coloured and sweeter. AVG treated fruit are likely to be firmer, enabling them to handle the supply chain better.

We are still awaiting results from our second season of experimental work in Vietnam but this approach should be of use. Various types of packaging have been tested to reduce damage caused during transport because of impact and temperature. The most common packaging system in use currently is cardboard boxes which are packed with 30 kg of fruit. A number of improvements were trialled during 2006 but unfortunately resulted in no improvement to fruit quality after transport. We will be trying more packaging systems during 2007.

The value of refrigeration (at 12°C) has been demonstrated experimentally. In the future refrigerated overnight rail transport from Lao Cai City would greatly improve the quality of fruit arriving at Hanoi markets. Despite our experimental proof of feasibility this form of transport remains conditional upon improvements in the quality of Vietnamese peaches and plums justifying expenditure.

Training remains a strong focus of this project. In addition to in-country training, five Vietnamese project scientists have visited Australia for training during 2005-06. Training has included orchard management, integrated pest and disease management, postharvest handling techniques and curation of plant disease collections.

Formal extension of project results will commence during 2007. In preparation for this a number of extension orchards have been established across the Sa Pa, Bac Ha and Moc Chau regions. Individual orchards are small (<1ha) and provide comparisons between traditionally managed trees and those managed using techniques tested experimentally during this project. Improved varieties introduced by an earlier ACIAR project are not widely available to growers at present. The Vietnamese government has recently approved commercial release of a number of these varieties. The coincident release of improved germplasm and training will improve fruit quality. This quality improvement will facilitate improvement along the supply chain as better financial returns justify infrastructure investment.

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

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	University of Sydney, Faculty of Agriculture, Australia
Project Leader	Professor Lester Burgess Phone: 02 93512526 Fax: 02 93516481 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, and
- develop control measures in collaboration with farmers.

Project progress

Objective 1: Training of provincial staff in basic laboratory diagnostics

Three training workshops have now been held. The first, at Hanoi Agricultural University (HAU), in November 2005 involved basic training in laboratory techniques, in Vietnamese, by project staff from HAU. Subsequently two workshops were held in Quang Nam, in January and April 2006 for six staff from all three provincial laboratories. Each of these workshops involved disease surveys of key crops, diagnostic training in the laboratory and farmer consultation focussing on ginger, peanuts and the major vegetable crops. The surveys also contributed to Objective 3. These two workshops also integrated 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 three of the six 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).

Objective 2: Establish basic fungal diagnostic laboratories

These laboratories were established and operational by January 2006, in time for the first surveys.

Objective 3: Implement limited surveys of nominated fungal diseases

Intensive surveys of quick wilt of black pepper and pathogenicity tests have shown that this disease is caused by *Phytophthora capsici*. This work is part of Mr Nguyen Vinh Troung's PhD. Intensive surveys of pineapple heart rot and pathogenicity tests have shown that *P. nicotianae* is the dominant *Phytophthora* species involved. This work is part of Mrs Dang Luu Hoa's MScAgr degree. The cause of ginger decline surveyed in January has not been determined. It will be a focus of studies in January 2007 and Dr Mark Fegan (University of Queensland) is assisting with the identification of bacterial cultures from diseased plants. Preliminary studies on peanut root rot suggest it is caused by a complex of fungal pathogens including *Pythium* sp. An intensive survey of this disease will be undertaken in April 2007. *Didymella* sp. was the only pathogen associated with the limited outbreaks of watermelon gummosis surveyed in April.

The surveys of fungal diseases of vegetable crops in Quang Nam, a part of the training workshops in January and April, revealed that *Sclerotinia sclerotiorum* is a key disease of short and tall beans and that *Phytophthora capsici*, *Sclerotium rolfsii* and *Ralstonia solanacearum* are key pathogens of chilli (a major crop). Furthermore bacterial wilt, caused by *R. solanacearum*, was diagnosed in a range of other crops such as tomato, bitter melon and tobacco, based on isolations from farmer-supplied samples and survey samples. This pathogen is obviously of significant economic importance. The disease in the past may have been mistaken for *Fusarium* wilt.

The initial survey of coffee decline indicates that the problem may be a consequence of termite damage of the bark of the upper tap root and lower stem. This facilitates infection by fungal pathogens which then develop a slowly spreading root rot.

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

See comments under Objective 1.

Objective 5: Pathogenicity tests of cultures from surveys

Pathogenicity tests have been completed to demonstrate that *Phytophthora nicotianae* is the major cause of pineapple heart rot and *P. capsici* is the major cause of quick wilt of black pepper. Pathogenicity tests have also been completed with *R. solanacearum*, *S. rolfsii* and *S. sclerotiorum*.

Objective 6: Implement field trials to evaluate control measures

A small field trial was initiated in late 2005 to evaluate methodology for treating black pepper with phosphonate, following successful screenhouse trials. The results of fungicide trials in the screenhouse for control of pineapple heart rot are being analysed, but several treatments were clearly successful. Major field trials in control of both diseases will be initiated in the summer of 2007. The feasibility of trialling insecticides to control termite damage in coffee seedlings and young trees is being discussed with entomologists in the Northern Territory and Vietnam.

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

No major modifications are proposed to this objective. However the manual on basic diagnostic guidelines for fungal plant diseases commissioned by ACIAR will provide an invaluable resource for teaching and day-to-day activities of staff in provincial and other diagnostic laboratories in Vietnam. Professor Burgess and Mr Timothy Knight have brought together a wide range of illustrative material for use in this manual. This will be useful in preparing other training materials.

CP/2005/053: Plant disease diagnostic manual

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
Collaborating Institutions	
Project Budget	\$30,000
Project Duration	01/05/2006 to 31/01/2007 (Project extended from 01/11/2006 to 31/01/2007)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

This manual will contain guidelines on methods most commonly used to diagnose plant diseases. Recommendations for 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, 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 bacteria, fungi, virus, mycoplasma and nematode pathogens. This includes correct identification of diseased plant and plant parts, sample collection, preservation, studies of visual symptoms on plants and presence or signs of biotic agents on affected plant parts, isolation techniques, sourcing published reference and illustrations, knowledge of 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 is a collation of disease information, illustrations and training notes used in disease diagnosis from the following concluded and active ACIAR projects: 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

First progress report due in 2007.

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

Overseas Collaborating Countries	Indonesia, 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 1535 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	\$352,380
Project Duration	01/07/2004 to 31/03/2007 (Project extended to 31/03/2007)
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, sending many populations 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 aquaculturing, providing some barriers to production can be overcome. Past ACIAR-supported research has developed laboratory-scale technologies for hatching 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 based on meeting nutritional needs can be formulated, 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.

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; and
- formulate and evaluate improved diets.

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 form a basis for developing artificial feeds optimised for mud crab aquaculture. This will require 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.

Project progress

Year 2 (01/07/2005–30/06/2006)

In September 2004, the project leader A/Professor Peter Mather and Queensland University of Technology (QUT) research scientists Dr Alex Anderson and Dr Neil Richardson travelled to Nha Trang, Vietnam to meet with ACIAR partners from Research Institute for Aquaculture No.3 (RIA3) to initiate the project. They held discussions with RIA3 Deputy Director Dr Thu and senior Research Scientists Mr Thach and Mr Le Vin regarding research priorities and methods. Agreements were reached on the experimental protocols required;

- To establish protein and lipid requirements for juvenile mud crabs during grow out
- To assess the respective digestibility of local feed ingredients with the potential to replace fishmeal in formulated diets.

During this visit Drs Anderson and Richardson also travelled to a commercial mud crab hatchery in Hue to observe crablet production of the indigenous species in Vietnam, *Scylla paramamosian*.

Unfortunately, due to Australian government alerts about security threats in Indonesia it was not possible to visit the Indonesian ACIAR partners in 2004. Nevertheless, regular e-mail correspondence was maintained with Project Leader in Indonesia, Mr Ketut Suwirya at the Gondol Research Institute for Mariculture (GRIM), Bali and growth trials were initiated aimed at determining optimum protein and lipid requirements for juvenile mud crabs (*S. paramamosian*). In May 2005, A/ Prof. Peter Mather and Drs Anderson and Richardson travelled to GRIM to meet with the Indonesian ACIAR partners. These meetings confirmed that excellent progress was being made with the growth studies at GRIM.

Progress to Date

Growth trials aimed at determining optimum protein and lipid levels in mud crab diets have been completed at all three ACIAR partner institutions (RIA3 GRIM and BIARC). Overall the general trends to emerge from the trials were very similar. Specifically, optimum growth rates and feeding efficiencies were achieved with diets containing between 42 and 47% crude protein and 7–12% lipid. There were, however, significant differences in the maximum rates of growth exhibited by crabs at the different institutions. While the basis of these differences is unclear, we suggest that they may arise from variations in the quality of local ingredients used to formulate diets or differences in the average weight of crabs used at the commencement of the trials at each locality.

An unexpected finding to emerge from the mud crab growth trial conducted at Bribie Island Aquaculture Research Centre (BIARC) in Australia was that high rates of growth could be obtained with the indigenous mud crab species *S. serrata* using a commercial tiger prawn diet. This tiger prawn diet (Turbo; Thailand) promoted rates of growth equal to those achieved with a kuruma prawn diet (Ebistar, Higashimaru; Japan) previously used as the standard mud crab diet during grow out. Moreover, the Turbo tiger prawn diet contains 15% less crude protein than the Ebistar kuruma prawn diet and is 80% cheaper.

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

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	\$854,980
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 \$A50 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 done sustainably—aquaculture being the only way of achieving this. In Vietnam the production of cultured lobster is estimated around \$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 1 (01/01/2005–31/12/2005)

Delays in obtaining signed Project Agreements between the contractual parties meant that research activities of the project did not commence until July–August 2005. Consequently, project start-up was delayed by 6+ months. This delayed start, in the context of the project as a whole, should not greatly affect the delivery of the planned outputs.

Ecological impact of lobster seed collection in Viet Nam

A pilot census of lobster seed collection in Khanh Hoa Province was carried out by Institute of Oceanography Nha Trang (ION) during October 2005 to trial census procedures. A full census is now being implemented to survey lobster seed collection in the seven central coast provinces of Vietnam where lobster settlement occurs. A total of 82 lobster seed merchants have been identified who operate in the south central provinces and information on seed collection has been obtained from 38 of these dealers. University of Fisheries (UoF) is implementing a survey of the seasonal incidence of breeding activity of caged lobsters. These surveys by ION and UoF will continue for the life of the project and will provide reliable data for use in estimating the sustainability of lobster culture in Vietnam.

Reducing post-capture losses of seed lobsters

Lobster seed merchants at three major landing ports of Bai Xep (Binh Dinh), Xuan Dai (Phu Yen) and Nha Phu (Khanh Hoa) have been interviewed, to determine the procedures used to hold and distribute captured lobster seed. Based on this information, Research Institute for Aquaculture No. 3 (RIA3) is examining the effects of different holding methods (stocking density, holding duration and feed type) and transport conditions on lobster survival over the critical 30-day post capture period. Because lobster vitality appears to be strongly related to settlement time, experiments will be done with lobster seed collected early, mid and late in the settlement season to examine seasonality effects. Preliminary results with early season pre-juveniles suggest that extending the time between capture and placement in nursery cages from 1 to 2 days markedly reduces the ultimate survival of the lobsters during the 30-day nursery period. Stocking density is not a major factor affecting lobster survival whereas long transport times (6 or more hours) are, with nursery survival rates below 27%. Feeding Kuruma shrimp pellets during the nursery period resulted in survival rates and weight gains only slightly worse than feeding trash fish.

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 has been planned by ION to commence early 2006. Suitable culture sites at Nha Phu Bay (Khanh Hoa) have been identified and lobster farmers from Xuan Tu village have agreed to collaborate in the work. The experiment will be carried out over 18 months with production, environmental and food safety data being collected at 6-monthly intervals.

Improving lobster grow-out feeds:

In Viet Nam, UoF 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 addition to determining how best to combine the different types of trash fish that are available, the work will examine different methods of moist pellet production, including transglutaminase enzyme binding, which is thought to offer the best prospects for developing an effective means of binding and yet simple enough to be carried out on-farm. At CSIRO, two experiments have been carried out to determine 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. Results for the first four feed ingredients are available and show that protein digestibility was high for all ingredients (84–89%) but the digestibility of dry matter, lipid and energy varied inversely with the amount of ash and chitin in the meal. CSIRO research in 2006 will determine the dietary cholesterol requirement of juvenile (2–50 g) and sub-adult (500 g +) lobsters.

Land-based systems for lobster culture:

Major tasks for Queensland Department of Primary Industries & Fisheries (QDPIF) during this period was to appoint staff, establish experimental grow-out systems and develop lobster seed collection processes and tools to effectively secure sufficient numbers of juvenile lobsters to sustain the experimental program for both QDPIF and CSIRO Marine Research & Atmospheric Research (CSIRO). Staff have been appointed and two 16-unit experimental systems have been established at Northern Fisheries Centre. However, the delayed start of the project meant that it was late in the settlement season when collectors could be deployed and only small numbers of seed lobsters were captured. These were used by QDPIF to commence a 3-month experiment investigating the effect of lobster size uniformity on growth and survival of the lobsters. The hypothesis is that a narrow size range within a collective group of lobsters will benefit the overall survival and growth of that group, and that regular size grading will be a useful tool in improving productivity of commercial operations. Four size ranges (20, 40, 60 or 80% variation around the mean) are being examined. The experiment is due to be completed in January 2006.

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

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 30/06/2007
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 for growing 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 cost of these is 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 requirements in juvenile fish are 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 (Vietnam/Cambodia) 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 2 (01/01/2005–31/12/2005)

Objective 1a: Develop diets based on locally-available ingredients for improved production of catfish and tilapia. Progress has been made in collecting a range of ingredient samples for a collective ingredient database, including the source history and diversity of species involved in some resource (trash-fish). Composition of samples collected has been determined. Determination of the digestible value of eight key ingredients has been determined.

Objective 1b: Nutritional requirements of fish species in Vietnam & Cambodia.

Growth data and samples of tilapia and catfish from commercial farms have been collected in both northern and southern Vietnam. Data and/or sample status from Cambodia has been poor, but has significantly improved with the location of an Australian Volunteers International (AVI) person (Mr Daniel Wright) with the group. Some experiments were re-run during 2005–2006 based on the assessment of data in November 2005. Data collected and samples have been analysed and will be used in constructing preliminary factorial growth models in August 2006. This data review will also allow for assessment to identify gaps where further samples and/or farm data are required for completion of the models by November 2006. Maintenance energetics trials on tilapia and catfish were re-run in both northern and southern Vietnam. Sample analysis from these trials has also been completed. Energy utilisation efficiency trial completed for catfish.

Objective 1b: Nutritional requirements of barramundi in Australia.

First and second growth trials completed. The first trial examined growth of barramundi at two size classes (20 g and 140 g) from 23 to 38°C. The second trial forms block 1 of a two-block study examining the metabolic energy demand across the same temperature range, but uses animals from 10 to 500 g. The existing growth and metabolic models developed by Dr Glencross have been refined based on the higher temperature data derived from experiments 1 and 2.

Objective 1c: Diet formulation for catfish, tilapia and barramundi.

Preliminary formulations have been provided to some collaborators, but have not yet progressed to the development of iterative diet designs before completion of growth models based on the maintenance and growth energetic data assessments. This objective is not expected to be met until year 3.

Objective 2a: Demonstrate/evaluate the potential of new improved feeds in on-farm trials.

Final component of the project; plans for development of field strategies to examine this will be developed during the Nov 2006 site visits. Further progress against this objective is still premature until complete bio-energetic models have been developed. These models will be given preliminary examination in August 2006, with further completion in Nov 2006. Progress against this objective is planned for years 2 and 3 of the project.

Objective 3a: Transfer technology and extend information.

Workshops for the project participants were held in Can Tho in June 2005. They provided the participants with a greater degree of detail in the basis behind the models being developed, as well as the steps and techniques required to build their own models. Time was also spent with each of the partner country collaborators present, reviewing their existing data-sets.

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

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 Phone: 07 4035 0109 Fax: 07 4035 6703 Email: mike.rimmer@dpi.qld.gov.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	\$887,704
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 2 (01/07/2005–30/06/2006)

Hatchery technology

Collaborative activities between researchers at Gondol Research Institute for Mariculture, Bali, and the Philippines have commenced to transfer hatchery production technologies to improve hatchery production through improved larval nutrition. This work will particularly focus on coral trout, *Plectropomus leopardus*.

Mr Ketut Suwirya (GRIM Bali) visited Northern Fisheries Centre, Cairns, in February 2006 for training in larval enzyme analysis techniques. DPI&F staff made a follow-up visit to GRIM in April 2006 to continue development of larval enzyme analyses with material supplied by GRIM and to initiate collaborative experiments: 1) sampling protocols for reef fish larvae for digestive enzyme analysis developed and tested successfully; 2) a time series of *Plectropomus leopardus* larvae; and juveniles sampled to provide baseline data on digestive enzyme ontogeny in this species; 3) samples of different-sized *P. leopardus* larvae at the same age sampled to provide better information on the impacts of size stratification amongst same-age cohorts of larvae; 4) a series of follow-on experiments developed and agreed for implementation following the project visit.

Develop cost-effective grow-out diets

Digestibility of alternative feed ingredients: The apparent digestibility of eight local feed ingredients that could be used for pelleted grouper feeds was determined in two experiments with juvenile tiger grouper at Research Institute for Coastal Aquaculture (RICA), Maros, Southern Sulawesi. Each experiment entailed a reference diet and four test diets in which the test feed ingredient was substituted at 40% for poultry offal meal, mysid meal, golden snail meal or green mussel meal or 30% for rice bran, yellow corn, white corn or sorghum. Dry matter, protein, lipid and energy digestibility coefficients ranged from 59.4 to 69.9%, 83.4 to 88.9%, 62.0 to 93.9% and 70.8 to 82.8% respectively for the animal meals and from 36.3 to 52.5%, 41.3 to 52.1%, 23.7 to 65.8% and 39.1 to 45.1% for the plant meals, respectively. The digestibility of golden snail meal was consistently lower than other animal meals. This information will enable grow-out feeds for tiger grouper to be formulated on a least-cost digestible nutrient basis.

Substitution of fish meal: Golden snails are a prevalent and difficult-to-control pest of rice paddy fields that may have potential as a partial replacement of fish meal in grow-out feeds for grouper. Although the digestibility of golden snail meal was shown to be less than other animal protein sources, it is nonetheless a cheap and readily available alternative protein source. Research at RICA Maros demonstrated that replacement of fishmeal at inclusion rates of up to 20% did not adversely affect growth and survival of tiger grouper.

Five farmers and staff from Yayasan Palu Hijau (Central Sulawesi) attended a short course on grouper feed management at RICA Maros from 19 to 23 September 2005. Central Sulawesi has suffered substantial degradation of 'trash' fish stocks to support growing demand for feed for reef fish caught and held or grown out in cages for the live reef food fish trade. The training undertaken by Maros staff is intended to provide YPH staff with the technical skills to influence fishermen to use alternatives to 'trash' fish.

Asia-Pacific Marine Finfish Aquaculture Network

Five editions of the Marine Finfish Aquaculture e-Newsletter were produced (Nos 27–31). There are currently 1130 subscribers to the e-Newsletter. Four editions of the AMPFAN e-Magazine (Nos 5–8) were included in 'Aquaculture Asia' magazine. Downloads of electronic versions of individual magazines range from 567 to 2582 per issue; there are about 350 subscribers to the printed version.

The publications 'A Guide to Small-scale Marine Finfish Hatchery Technology' and 'A Practical Guide to Feeds and Feeding for Cultured Groupers' have been translated into Thai by Department of Fisheries staff. Both guides have been used by Thai DOF staff for training. The publication 'A Guide to Small-scale Marine Finfish Hatchery Technology' was also translated into Vietnamese through the Support to Marine Aquaculture Development (SUMA) program. Around 1000 copies have been disseminated to farmers throughout Vietnam.

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

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 1535 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	\$340,633
Project Duration	01/01/2004 to 30/01/2007 (Project extended from 01/01/2006 to 30/01/2007)
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, has 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 fish 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 Mekong River Basin.

Project progress

Year 2 (01/01/2005–31/12/2005)

Two visits were conducted during the specified reporting period. The project leader, research associate and an Honours student at QUT (Ms Ellie Adamson) travelled to Cambodia and Thailand in June 2005 to conduct the first project workshop entitled: 'Application of Population Genetic Approaches to Fisheries Management in the Mekong River Basin (MRB)'. This meeting was attended by representatives of the four MRC partner countries and the focus of the workshop was to present in lecture and tutorial sessions the foundation of the theory and practice behind using population genetic technologies to identify discrete fish stocks.

Prior to the workshop, the Australian partners had discussions with the Director of RIA2 (Dr Hao) and relevant staff in HCMC, Vietnam and the Director and Deputy Director of Inland Fisheries, Cambodia (Mr. Nouk and Mr Lieng Sopha) in Phnom Penh about the project and to organise additional collection of tissue samples.

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

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 Fax: 02 6651 5027 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 usability 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 guide the choice of eucalypts suitable for short-rotation use and the silvicultural management of these species.

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

Project progress

Year 1 (01/07/2005–30/06/2006)

The joint FST/1999/95 and FST/2001/21 project inception meeting was held in Zhanjiang, Guangdong, China in December 2006. Held to coincide with the ITTO / IUFRO meeting “International Conference on Plantation Eucalyptus: Challenge in Product Development” this meeting was attended by 34 people representing project partners and other interested stakeholders. The meeting served two purposes:

1. Updating the current state of knowledge: each project partner made presentations of their current research and development, as well as advancements in technologies for assessing wood quality.
2. Detailed planning of project trial assessments as well as identification of training needs in each of the partner organisations.

After the inception meeting project partners were trained in two non-destructive wood property assessment techniques in a clonal trial in Dongmen Forestry Farm. A total of 61 trees representing 15 clones were assessed in the trial. The historical growth data along with this wood quality data were analysed to bench mark the single clone represented in Dongmen Experiment 84, a spacing and fertiliser trial that is the focus of the project's first main detailed wood quality assessment in China planned for September 2006. In support of the planned assessment Guangxi Forestry Research Institute and Dongmen Forestry Farm assessed growth and form in Experiment 84. These data were analysed and used to identify trees that will be sampled in the future wood quality assessment. At the inception meeting the private pulp and paper company Stora Enso Forestry Guangxi agreed to support the project by providing pulp wood assessment of trees harvested in trials E73 and E84. This will enable the project to evaluate the impact of silviculture on pulp wood production and quality in addition to the project's focus on solid wood.

Project work in Australia kicked off with the assessment of a *Eucalyptus pilularis* progeny trial. With support from Australia's Forest and Wood Products Research and Development Corporation (supporting drying and wood chemistry evaluation) and the CRC for Forestry (supporting molecular genetic work) this will be the most comprehensive study into the genetic control of wood properties of *Eucalyptus* completed to date. Standing tree assessment of the trial was completed in June 2006 after approximately 9 months of field work. This project provided the opportunity to train two Chinese scientists in non-destructive techniques for the assessment of wood properties.

Dang Phouc Dai, a project scientist from Vietnam, was awarded a John Allwright Fellowship to study for a PhD at Southern Cross University. His studies will be on genetic variation in growth and wood properties in *Eucalyptus pellita* in Vietnam and Australia. Li Bohai, Chen Shaoxiong and Luo Jianzhong, all key members of the project team in China, will study for PhDs at Chinese universities. Their studies will directly be related to the project's activities and goals.

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

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 as well as 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 to make greater use of indigenous and other high-value tropical tree species in reforestation projects in Vietnam and Australia.

Project progress

Year 4 (01/01/2005–31/12/2005)

Objective 1: Socio-economic circumstances of farmers

Further analyses of the large survey (n = 210 households) we undertook in three provinces in NW Vietnam have been carried out. The survey showed that circumstances and information needs of farmers across this large region are not identical. Accordingly, we have developed a typology of farm households based on the amount of land each household has potentially available for reforestation and on household income. We have identified five groups and are using this classification to explore the level of interest each group has in reforestation, the type of reforestation each group is interested in undertaking and the information needs (i.e. research questions) of each group. With this knowledge we will be in a better position to decide how to pass on our research findings.

Several types of silvicultural system have been identified for use by farmers (see below) and we have undertaken financial analyses of these based on a range of likely prices and increment rates. Although we have quantified mill door prices of a large range of species we have rather less satisfactory knowledge of harvesting and transport cost and of the fees and taxes that must be paid in bringing timber to processing centres. We are hoping to gather this information in the next few months.

Guidelines are now being developed on how these different systems might be used by different types of farmers. We plan to outline these guidelines at a workshop in Vietnam in early 2006, and to adjust them in the light of responses received then.

Objective 2: Performance of high-value trees in existing plantations

The large survey of existing tree plantations across the region was essentially completed during the year. Altogether we now have data from 77 plantations at 32 sites. Over 45 tree species were measured in the surveys. Most of these species were younger than 10–15 years old. In order to develop estimates of the likely future growth within the time span of interest to farmers (e.g. to age 30–40) we used a Chapman Richards function to estimate tree sizes at 30 years. From this we can estimate nominal mean annual growth increments for each species. We are using these estimates in the financial analyses referred to above.

We have used the frequency at which particular species occur in various farm plantations (which is partly a consequence of farmer preferences and partly a legacy of suggestions or directives by government agencies) as well as site tolerances, growth rates and timber prices (see below) to identify a list of 10 best-bet species for use in reforestation across the region. Different combinations of these species have been used in the various silvicultural systems referred to above.

Work has also been done on site conditions (especially soil pH, since most sites are very acidic) and nutrient status of the various species. The intention is to use this to help define species–site relationships rather more carefully.

Objective 3: Competitive relationships in mixed species plantations

There are various mixtures that have been used or might be used by farmers. We have developed a portfolio of 10 silvicultural systems we think are appropriate to farmers in the region. Six of these systems involve mixtures. The competitive relationships between species in these mixtures vary, depending on whether the mixture is permanent or temporary.

In the case of permanent mixtures we have used three approaches to identify ways of measuring competitiveness so we can assemble stable mixtures. One is via empirical field trials (see further in Objective 4 below). Several such trials were established in 2002 and have been monitored annually since then. A second approach is by assessing relative competitive abilities of different species using competition indices. We have used these to explore the competitive abilities of most of our key best-bet species. The data have come from existing plantings and from our own field trials. There are problems in using some of the existing older plantings, since spacings and management histories are often variable. On the other hand, our own trials are still comparatively young. None-the-less some useful data have been collected and the results will be presented at the February 2006 Workshop.

The third approach is to use computer modelling and this is being carried out within the Rainforest CRC as part of the Australian component of the project. The postgraduate student doing this work has been using field trials established in north Queensland by Dr Huynh Duc Nhan when he was a post graduate student in Australia. Although not funded by ACIAR the researcher has won an Australian Volunteer International fellowship and will spend three months at the FRC in early 2006. We expect this approach might help to generalise relationships between species and planting designs in Vietnam beyond the empirical data we are collecting at field trials.

Objective 4: Assess performance of high-value trees and comparison of plantation monocultures and mixtures

Measurements of several field trials involving empirical mixtures that were established in 2002 have continued. The trials are now only three years and, as yet, no statistically valid differences between monocultures and mixtures—either positive or negative—have been established. These will continue to be monitored. As noted above, the data from these will be used to generate some models of plantation growth.

Objective 5: Institutional support

Australian research staff visits provided institutional support during the year, conducting, a formal training course on research methodologies. Other support came from the permanent presence of several Australian Youth Ambassadors for Development volunteers, who spent most of the year working in partnership with key FRC staff.

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

Overseas Collaborating Countries	China, Vietnam
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Dr Russell Washusen 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 to plant 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 (less than 30 cm) logs are used, but growth stresses are released when these are sawn using traditional approaches, splitting logs and rending them useless. Such constraints, plus the tendency of plantation-grown eucalypt wood to distort, have discouraged use. The project objectives are to:

- improve the processing efficiency 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 1 (01/07/2005–30/06/2006)

This project officially commenced with a joint inception meeting along with FST/1999/095 in Zhanjiang, Guangdong Province, China in November 2005. These two ACIAR projects are closely linked using the same plantations and time-frame for research. This meeting was conducted immediately after the IUFRO/ITTO "International Conference on Plantation Eucalyptus—Challenge in Product Development" held in Zhanjiang. This conference was held as a final reporting session for a large ITTO project to develop processing of eucalypts in China.

The inception meeting was attended by representatives of Ensis, CERC, FSIV, University of Melbourne, Queensland Department of Primary Industries, Forestry Tasmania, Forests NSW, Stora Enso, Guangxi Forestry Research Institute, Guangxi Dongmen Forest Farm, Hunan Provincial Department and Beijing University. The inception meeting identified/confirmed (partly through the experience of the ITTO Project) the technological limitations in sawmilling and wood drying systems in both China and Vietnam that was recognised during project development. These identified limitations highlighted the importance of introducing or developing suitable technology and developing tree growing and processing skills in China and Vietnam.

Ensis attempted to overcome the deficiency in sawmilling technology with the assistance of Karasaw Australia. This assistance was additional collaboration unforeseen during project development. Karasaw Australia supply equipment in Australia that has been developed by Kallion Konepaja Oy (Kara) in Finland. Scientists from China were invited to Brisbane, Australia to inspect potential technology that may be introduced into China and Vietnam to develop small-scale sawmilling industries processing small diameter eucalypt logs from farm-based woodlots. Vietnamese and Chinese scientists also participated in trials processing 15–25 cm diameter *Eucalyptus fastigata* logs at the Timber Training Centre, Creswick, Victoria to test the suitability of a Kara PPS 500 multi-saw system imported into Australia from Finland. The trials indicated that the system may potentially meet this need with modification of the saws and mill design. Karasaw Australia is currently modifying the mill for potential processing of small-diameter eucalypts in small regionally based sawmills in Australia, China and Vietnam.

In April 2006 five scientists from China and Vietnam attended a training session at the Timber Training Centre in Creswick, Victoria to train/upgrade skills in eucalypt timber sawing and wood drying, and were introduced to processing research procedures. While in Australia the scientists visited the University of Melbourne's Centre for Advanced Wood Processing and the CRC-Wood Innovations and were introduced to the microwave pre-treatment technology in solid wood processing. They also visited industrial sites in Victoria and New South Wales and intensively managed eucalypt farm forests in southern and northern Victoria.

In June/July 2006 the first of the larger-scale processing trials was conducted in collaboration with Forests NSW and N.F. McDonnell & Sons in Victoria. This trial used four provenances of *E. nitens* with measured peripheral growth strain levels to assess the potential for a HewSaw R250 (or similar technology) to process eucalypts with a range of growth strain levels, and the potential for genetic improvement in resources developed for this processing technology. The HewSaw R250 is one of a number of sawing machines developed by the Viesto Group that applies chippers and saws in modern sawmill designs with potential to alleviate stresses that cause processing difficulties in eucalypts. Unlike the Kara PPS 500 the HewSaw R250 is a high throughput mill suitable for large-scale industrial processing.

Assessment of the SilviScan technology in application for improvement in eucalypt resources for solid wood processing end-uses is largely complete. This work included an assessment of wood microstructure in a University of Melbourne, School of Forestry and Ecosystem Science *Eucalyptus globulus* silvicultural trial located in eastern Victoria. The effect of thinning and fertiliser application on wood microstructure was assessed and processing trials conducted in trees that represented the range in the variation found. Two draft reports have been prepared and two papers published in *Wood Science and Technology* and in the proceedings of the IUFRO/ITTO Conference held in Zhanjiang.

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

Overseas Collaborating Countries	Laos, Thailand, Vietnam
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Mr Khongsak Pinyopusarerk Phone: 02 6281 8247 Fax: 02 6281 8266 Email: khongsak.pinyopusarerk@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 1 (01/07/2005–30/06/2006)

Whilst the proposed start date for this project was the 1st July 2005, the project only started in March 2006 following the completion of contractual agreements between the various parties. This report therefore reflects project activities between March and June 2006. As a result of these time delays a number of project activities have had to be rescheduled. Key activities have been:

1. Inception meeting through visits by Ensis project staff to meet with project staff in the collaborating countries, i.e. Thailand, Laos and Vietnam. These meetings serve to discuss the activities under the project, their scheduling and staff involved and visits to field trial sites established under the previous ACIAR project FST1996/005.
2. Visit to Vietnam by Dr Manon Griffiths as part of a training workshop in assessing influence of shade on *Hypsipyla* damage in *Chukrasia* trials.
3. In Vietnam, RCFTI have continued to maintain the *Chukrasia* trials at Cam Quy and Binh Thanh companion trials. Clonal material has also been maintained in the Ba Vi nursery with work under way to bulk up the number of plants required for the establishment of two clonal trials under the project. The trial site for the two clonal trials—one as pure species and a second companion planting with *Acacia* hybrid—has been selected. The *Acacia* hybrid was planted in September 2005.
4. In Thailand, RFD has continued to maintain three *Chukrasia* provenance trials at Ratchaburi, Kuiburi and Kanchanaburi, Preparation of rooted cuttings material for clonal trials is under way.
5. In Laos, the *Chukrasia* provenance trial at the Agroforestry Research Station at Thongkhang, Luangprabang continues to be maintained, although there have been heavy plant losses. An assessment of the trial was carried out in 2005 as part of a university student assignment focusing on basic information about growth and survival. More detailed assessment will be carried out by project personnel during the reporting period.
6. In Queensland DPI&F have continued to maintain sites at Imbil (genetic resource trial) and north Queensland (two shading trials). Assessments have been made at Imbil (August 2004) and north Queensland (October 2004, October 2005).

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

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 Fax: 03 6226 7942 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 30/06/2008
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Several species of Australian acacias 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 that species will reproduce and spread beyond plantations or planned growth to become invasive weeds when introduced into exotic environments. 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 2 (01/01/2005–31/12/2005)

Two approaches using colchicine have been successful in producing tetraploid *A. mangium* plants from elite seed supplied by RCFTI, Vietnam. Each approach has produced 2N, 4N, mixoploids (plants with both 2N and 4N cells) and mosaics (plants consisting of 2N, 4N and/or mixoploid parts). These plants are being monitored for stability and or reversion to diploid to determine if method of polyploid induction affects plant stability. The preferred methods will be scaled up for production of more polyploid lines for transfer to RCFTI.

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, stomata size and density measurements, and most recently the use of Near Infra Red Spectrometry.

CSIR has identified suitable germplasm to begin induction on both clonal and improved seed material. Material was selected on the basis of field performance as well as potential commercial value. Four hybrid clones with *E. grandis* and two pure *E. grandis* clones will be used plus a number of pure and hybrid seedlots. A single tetraploid line of CSIR germplasm was sent back to CSIR by Shell Forestry and successfully propagated. This can now be planted out and treated with paclobutrazol to promote flowering and therefore triploid production. It will also enable study of 2N and 4N lines to help with later identification of induced polyploids.

RCFTI forwarded 34 polyploid lines of Shell Forestry Ltd *A. mangium* clones as cuttings or as tissue culture to UTAS and 22 were captured with a range of 1 to 23 ramets per clone captured. A total of 115 ramets were screened for their ploidy using flow cytometry and stomatal assays. All lines were originally sent to RCFTI as tetraploids. Results show that eight lines have reverted to pure diploid, seven clones have ramets of different ploidy levels, one clone is mixoploid and five clones are tetraploid. Of these five 4N clones only one ramet was captured. This highlights another restraint in production, which is the greater difficulty in rooting tetraploid over diploid clones. These results reflect the findings in current UTAS experiments, where there has been incomplete transformation to 4N and reversions to 2N of experimental plants. Practical management of these biological complexities is a major focus for the project.

Q3 2005 was dedicated to organising and then conducting an intensive four-week training course for two scientists from RCFTI and one from CSIR. This was conducted by staff at UNE, Armidale and UTAS staff, Hobart in August/September 2005. Topics covered included: lecture series on acacia floral development, reproductive biology, hybridisation, polyploidy, sterility and pollen storage, together with guest lectures on 'Drought tolerance in *Acacia*', 'Use of polyploidy in hop breeding', and 'Timelines for operational deployment of polyploid acacia clones and potential genetic gain'.

Practical work covered pollen viability testing, UV microscopy and flower preparation, micro techniques for thin sections, chromosome counts, stomata preparations and measurements, colchicine experiments, flow cytometry preparations, herbarium visit. Field trips were undertaken to Smithton, NW Tasmania for management of native blackwood (*Acacia melanoxylon*) forests and to Washpool National Park, NSW.

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 in May 2006 to test for triploid status. Flowering in December 2006 will be closely monitored and a scientist from UTAS will visit to help implement control pollinations and collect 4N flowers and pollen for monitoring of polyploid pollen viability and flower/pollen size variations.

A visit by ENSIS staff established the set up of a mini-cutting propagation system at FSIV, Hanoi. This will be essential when propagating 4N lines and may be the quickest path to optimise number of converted plants by taking cuttings and rooting parts of the plant that has been identified as 4N. Advice was also supplied on optimising nutrition of the mobile polyploid seed orchard. Following Field inspections in August 2005 the Project Leader provided notes on the work program and recommendations for thinning and nutrition of field trials and priorities for DNA fingerprinting. These recommendations were confirmed in a follow-up visit by ENSIS staff; suggestions/comments were also recorded on the set up of the hydroponic min-cuttings system.

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

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Department of Primary Industries, Victoria, Australia
Project Leader	Dr Peter Doyle Phone: 03 58520503, 03 58520500 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 Department of Agriculture and Rural Development, Vietnam
Project Budget	\$607,476
Project Duration	01/04/2004 to 30/06/2007
ACIAR Research Program Manager	Dr Bill Winter

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 activities. There is considerable market potential for selling cattle, but knowledge on cattle feeding systems is limited. ACIAR has supported research in this area. leading to a workshop where 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 on 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. 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'*

Project progress

Year 2 (01/04/2005–31/03/2006)

The project coordinating committee 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 three times during the year. The committee comprises Prof Le Duc Ngoan, and Mr Nguyen Xuan Ba (Hue University of Agriculture and Forestry, HUAF), Dr Vu Chi Cuong (National Institute of Animal Husbandry, NIAH), Mr Trevor Ole (RUDEP), Eng. Cao Hoi (Department of Agriculture and Rural Development, DARD, Quang Ngai) and Dr Peter Doyle (PIRVic, DPI). It conducted a project workshop in November 2005 to facilitate communication of project findings in central Vietnam.

Key stakeholders from HUAF, the Ministry of Agriculture and Rural Development and the Ministry of Education and Training participated in the May 2006 meeting. Alignment of project activities with the needs of RUDEP and DARD has been ensured by obtaining inputs into the design of activities, and by reviewing progress with RUDEP and DARD staff.

Activity 2 has involved establishing inventories of the availability and nutritive characteristics of feeds in the lowland and highland zones of Quang Ngai. In the last year, a database of nutritive characteristics of feeds has been compiled from published data from Vietnam, and comparisons have been made with information in the international literature. The database covers four categories of feed, namely: forages, tree forages, on-farm supplements and off-farm supplements. Full reports in Vietnamese and English are complete for the feed inventory and nutritive characteristics database activities. An extension booklet has been designed and is now in draft form. It will be sent for review by DARD extension and Prof Vu Duy Giang, Hanoi Agricultural University.

The modelling approach used in ACIAR project LPS/1998/035 to design possible year-round feed combinations has been explored and adapted for use in Vietnam. Expert opinion is now required to assign quantitative values to the qualitative descriptions of availability of different feeds to use the modified model in Quang Ngai. This activity is on-going and linked to project activities 3 and 4.

In activity 3, two feeding experiments were conducted in Vietnam to provide data on liveweight gain responses to different combinations of forage and locally available concentrate supplements. Analysis of samples and data from the first experiment is largely complete and drafts of the results and data sets will be reviewed in DPI. The second experiment was completed in mid June 2006 and only preliminary results are available.

In this activity in Victoria, a second major metabolism experiment examining associative effects between fresh Persian clover pasture and different amounts of crushed wheat was completed in Spring 2005. The base production results, including feed intake, milk production and composition have been compiled, and analysis of feed and biological samples from this and the previous experiment will be completed over the next 6 months.

Planning for activity 4, verification of feeding options in lowland farming systems, occurred during visits to Vietnam in November 2005 and May 2006. The activity plans have been documented and circulated to RUDEP and DARD staff for inputs. Module 4 will be implemented in July/August 2006.

As part of activity 4 'Increase the knowledge and technical skills of scientists and extension staff in Vietnam and Australia' the project team has published two journal papers and five conference papers, and submitted two other journal papers and one other conference paper. Scientists have undertaken training in scientific writing and have broadened their knowledge and skills in research processes through on-the-job training activities. In addition, two postgraduate and seven undergraduate students have undertaken activities in the experiments in HUAF.

The project workshops in HUAF have broadened knowledge and skills in research across the project team and within HUAF. HUAF and its staff have strengthened linkages with NIAH and RUDEP through this project and have also established networks with international donors.

Construction of an animal house and feed preparation area at HUAF farm have been completed and resources for experimental work acquired.

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

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 South 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	Dr Bill Winter

Project background and objectives

The pig production sector 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 feedstuffs, 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.

The 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 2 (01/04/2005–31/03/2006)

During 2005 the characteristics of the Vietnam rubber production industry were surveyed, data were collected on rubber seed yields over time and for different varieties and ages of rubber trees. Fresh rubber seed were also harvested from plantations in Vietnam by collection within one day of dropping. These were frozen and bulked together. Sub-samples of these underwent a number of treatments using heat, pressure, washing and sun drying, following which they were chemically analysed for presence of residual hydrogen cyanide (HCN) and assessed for proximate chemical composition. They will undergo further analysis for amino acid content.

Analyses showed that HCN in rubber seed slowly declined at ambient temperature to less than 50% of the initial level after 150 days of room temperature storage. It was also observed that there was a substantial loss of water from the seed over time. The presence of the rubber seed hull limited the reducing effect of sun-drying on the cyanide content, with only the decorticated seed showing any decline in cyanide with sun drying, to about 16% of initial HCN level. Heat processing studies have shown that a number of high temperature processing methods, which utilised both wet or dry heat for period between 10-35 minutes, on both decorticated seed and un-decorticated rubber seed failed to significantly reduce the cyanide content of the rubber seed, although the boiling treatment suggested a lowering of the residual cyanide in the decorticated rubber seed.

Preliminary results using combinations of treatments in lab scale studies showed that if seeds were first either homogenised with water or crushed to extract the oil and moisture followed by sun drying then the cyanide content declined significantly with increased time in the sun. It was observed that after the water wash and one day of sun drying there was a significant reduction in HCN in chopped seeds, whereas after one day of sun drying there was only a lesser reduction in crushed seeds without the wash step. The removal of the hull prior to these processes enhancing the cyanide reduction response. The greatest rubber seed cyanide reduction was achieved in seeds that were initially decorticated, then crushed to remove oil and water followed by a homogenisation (wash) in water with a period of 2–5 days of sun-drying to yield a dry meal product with almost complete elimination of the HCN content. Further studies will continue to replicate this result on a larger scale with processing of bulk quantities of rubber seed which will be used to provide raw material for later pig digestibility and dietary inclusion feeding studies.

Survey work on cassava starch processing plants and the production of cassava residue was also completed. Sub-samples from both same and larger-scale mills were collected and evaluated for residue HCN. Analysis has shown that the processing and sun-drying produces a product with relatively consistent low HCN level. Samples are undergoing further chemical analysis and nutritive assessment. Pig digestibility studies and dietary inclusion feeding studies have commenced, 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.

Planning has commenced on further research into two other local Vietnamese feeds with identified newer properties, these being groundnut meal and sesame meal.

In Australia researchers have examined the digestible energy content of a number of sunflower meal types available and identified 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 will examine these apparent changes in more detail and assess the impact of such nutritive changes on the value of this feed in pig diet formulations.

During the reporting period a project planning review meeting was held in Vietnam in June 2005 with another project meeting and review in April 2006.

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

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
Collaborating Institutions	
Project Budget	\$77,000
Project Duration	01/04/2005 to 31/03/2009
ACIAR Research Program Manager	Dr Bill Winter

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 suitable technologies for application 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 1 (01/04/2005–31/03/2006)

This is a brief report of the project activity for the last three months for 2005.

- Completed the POA 06 and its Finsup for the project, they got approval from WV-Ha Noi office. (October, November, 2005)
- Worked with Project Management Board (PMB) and the District Extension Station (DES) with the POA 06 for implementation and management (November, 2005)
- Signed contract with Hue University of Agriculture and forestry (HUAF) for Agreement of providing services (November, 2005)
- Worked with HUAF consultants to complete a series of project implementation for the year 2006 (December, 2005)
- In November, 2005, the project conducted a workshop to review the 2 years of the social assistance loan for cattle production. Twenty-four members from 10 project management committees (PMCs), the PMB and District partners and World Vision staff attended the workshop. The workshop also welcomed the participation of the representative of ACIAR Hanoi office, along with Dr Peter Doyle and three consultants from HUAF.

The participants had the opportunity to review the cattle production from the loan beneficiaries for the last two years (2004 and 2005) and the real situation of the cattle production among the Ethnic Minority Group. Following are some findings that need attention :

- Local people do not pay much attention on cattle caring, They let their cattle wander on the hills and in the forest, The cowsheds look temporary and seem not to keep them in the cowsheds and they do not feed the with grass and provide water with salt to their animal.
- Most of the beneficiaries are poor, scattered in remote hamlets in 10 communes and the transportation is difficult so it is hard to communicate and to get information of cattle development and giving births.
- The network of commune Extension workers and Vet workers are not experienced and skillful enough to provide technical help and prompt action in such critical incidences. They were also busy with foot-and-mouth disease and the bird flu epidemic.
- The cattle sources are very rare, the price gets higher and higher and the foot-and-mouth disease and bird flu epidemic usually happen in this season so it affected to loan releasing and cattle purchasing.
- The weather has been poor (rain and cold) and it is also the hunger time in the area so farmers could not repay loans on time. Furthermore, the commune bookkeepers were busy with their own training so bookkeeping was very slow.
- A small number of cattle (eight cows) died. Most of the reasons are from the habits of allowing their animals to wander, with ropes around cattle necks, in cold weather.
- Some participants from lowland communes (Xa Ba, Xa Tu, Prao district town) were worried about the lack of food for the cattle and they would like to plan kinds of grass for food.

The participants also discussed some solutions to help farmers in cattle production such as:

- Plan a series of TOT technical trainings for the District Extension Workers, Commune-based extension workers as well as the Vet worker network.
- Provide on-farm technical training for farmers.
- Assist local farmers to grow grass for cattle.
- Assist the District Extension Station to vaccinate animals.
- Provide reinforced training for extension workers to adopt artificial insemination.

Challenges :

- HUAF consultants were so busy with their teaching job at schools so they could not arrange time to conduct training and relevant activities.
- WV staff was busy with year-end review of ADP FY05, 5-year Evaluation and Transformational Development Indicator survey and plans for the new FY 06.
- The agriculture staff in charge of the ACIAR project resigned and the ADP could not find an appropriate person in time.
- The network of commune extension workers and Vet workers was busy concentrating their work on the cattle foot-and-mouth disease in the area.

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

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	University of Sydney, Faculty of Agriculture, Australia
Project Leader	Professor Ivan Kennedy Phone: 02 93513546, mob: 0407 949 622 Fax: 02 93515108 Email: i.kennedy@acss.usyd.edu.au
Collaborating Institutions	CRC for Sustainable Rice Production, Australia Hanoi University of Science, Vietnam Institute of Agricultural Sciences of South Vietnam, Vietnam Can Tho University, Vietnam National Institute for Soils and Fertilisers, Vietnam
Project Budget	\$439,619
Project Duration	01/07/2004 to 30/06/2007
ACIAR Research Program Manager	Dr Ian Willett

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 is establishing inoculant biofertilisers for rice as a reliable technology and fostering extension of its application by studying its economic, social, and environmental benefits.

- Objective 1: Conduct field trials in Vietnam and Australia designed to optimise, extend and promote biofertiliser technology on rice farms for profit increase, extending this technology to the south of Vietnam.
- Objective 2: Design and evaluate a set of simple field tests for quality control of biofertiliser products aimed at ensuring their effectiveness under typical paddy rice field conditions.
- Objective 3: Investigate the economic and commercial feasibility of inoculant biofertiliser production in Vietnam.
- Objective 4: Conduct laboratory and field research to reveal the mechanisms of the PGPR biofertiliser effect.

Project progress

Year 2 (01/07/2005–30/06/2006)

This project has now been in progress for two years. After one year, positive results with the biofertiliser product known as BioGro obtained in two shorter projects funded by ACIAR and AusAID in the period 1999–2002 had been confirmed, although positive responses ranging from commercially important at Dai Mo village near Hanoi to relatively insignificant in a trial at Cu Chi near Ho Chi Minh City were obtained. Variations in rice yield up to about 1 tonne per hectare were obtained, depending on the microbial strain combinations used.

In the second year of the project a clearer understanding of the field conditions producing positive responses is being obtained. A new field trial to test whether there is a need for repeated inoculation set up at Dai Mo near Hanoi by Professor Hien of Hanoi University of Science (HUS) has confirmed the biofertiliser effect ($P < 0.05$). However, a repeat trial on the same plot sites showed considerable inconsistency between rice yield and strain combinations when comparing the year 1 results with those in the second year, and no significant yield response was obtained although the fact that the yield of the uninoculated control had increased suggested possible cross-inoculation of bacterial strains between plots. Another trial with high quality rice supervised by Dr Pham Van Toan in Nam Dinh province confirmed the biofertiliser response as significant, but only at limiting levels of urea application similar to those employed at Dai Mo.

Rice trials with BioGro have now been conducted in collaboration with Dr Laurie Lewin at the Yanco Rice Research Institute in year 1 and at the Australian Rice Institute at Jerilderie in the 2005–6 season. No statistically significant ($P < 0.05$) yield increase of rice grain was found with BioGro strains in the Yanco trial but a trend towards a positive effect from inoculation with *Rhizobium trifolii* from Egyptian clover (known to be an endophyte of rice) was confirmed in the Jerilderie trial. At panicle initiation, statistically significant gains in vegetative dry yield from inoculation with *Rhizobium* strain R4 responsive to the level of inoculant were obtained, although this effect diminished by grain harvest and was non-significant. We consider that the much longer growth period for Australian rice allows it to compensate for biofertiliser effects often apparent as yield increase with relatively short-season rice in Vietnam.

In September 2005, a Microbiology Workshop was held at Hanoi University of Science attended by 20 project participants from HUS, VASI and IAS, including two PhD students from the University of Sydney. The workshop considered microbial factors important in biofertiliser action, including classical and modern molecular quantitative methods of microbial isolation, counting and identification from inoculants such as peat. The concept of the *yield polygon* was introduced as a means of clarifying and possibly quantifying the actual potential for yield increase as a result of biofertiliser inoculation. This concept can accommodate the likelihood that variable responses to inoculation may indicate that the potential for yield increase is not indefinite and that in some cases, plant crop needs for nutrients may already be close to optimal, preventing a response. As a result, additional research was proposed for the ACIAR project, to obtain quantitative methods indicating yield potential for inoculation with, for example, phosphorus or nitrogen mobilisers, related to objective 4 in the project.

In March 2006 a project review workshop was held at the University of Sydney attended by Vietnamese colleagues, Professor Hien, Dr Cong and Dr Toan. The results of about 10 field trials conducted in the project were reviewed and important issues regarding application of biofertilisers that had been identified during the term of the ACIAR project were discussed.

Mr Michael Rose, a PhD candidate at the University of Sydney, was awarded an Australian Youth Ambassadorship from AusAID, to work in Vietnam associated with this ACIAR project. It is anticipated that his skills will add value to aspects of the project related to strain identification and quantification as well as the development of the concept of the yield polygon as a tool designed to predict conditions under which biofertiliser can be beneficial to farmers.

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

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Department of Natural Resources and Mines, Queensland, Australia
Project Leader	Dr Philip Moody Phone: 07 3896 9494 Fax: 07 3896 9623 Email: phil.moody@nrm.qld.gov.au
Collaborating Institutions	Institute of Agricultural Sciences of South Vietnam, Department of Soils and Fertilisers, Vietnam National Institute for Soils and Fertilisers, Department of Land Use Research, Vietnam World Vision of Vietnam, Bac Binh Area Development Program, Vietnam
Project Budget	\$395,995
Project Duration	01/01/2004 to 30/06/2007 (Project extended from 01/01/2007 to 30/06/2007)
ACIAR Research Program Manager	Dr Ian Willett

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 practiced 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 deficiencies in soils, compaction of soils and the presence of toxic chemical elements in soils.

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 Capability Classification (SCC) already exists; it uses measures and properties (texture, colour, etc.) of collected soil to identify constraints and indicate appropriate management strategies. Scaling this up for interpretation of soil constraints and management strategies to ameliorate or managing these at the village level is needed to help develop improved practices.

The project is providing 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 the SCC.

Project progress

Year 2 (01/01/2005–31/12/2005)

Vietnam

Maize biomass and grain yield responses were obtained on a Ferralsol soil to Tithonia residue addition (at 3 tonnes/ha) and bentonite addition (5 tonnes/ha), and these yields exceeded those obtained at the recommended rate of NPK fertiliser addition. It appears that increased productivity from these treatments is probably associated with increased CEC (and therefore increased capacity for retention of nutrient cations) and improved availability of phosphorus when added in organic form, but confirmation of these causes will depend on completion of soil and plant analyses.

On an Acrisol soil, maize biomass and grain yields were higher where bentonite (5 tonnes/ha) or a soil conditioner that increased soil water holding capacity (at 20 kg/ha) had been applied than where the recommended rate of NPK fertiliser had been applied. The reasons for these differential responses will be clarified when soil and plant analyses are completed, but it is suggested that improved soil moisture status may be the primary cause.

The results from these two sites indicate that different management strategies are required on different soil types to overcome soil constraints to productivity.

The transect of Ferralsol soils in Gia Lai has revealed the existence of soils with minimal surface charge ('geric' soils according to the FAO soil classification system). These soils present a challenge to nutrient management because of their inability to retain cation and anion nutrients for plant growth. Similar soils occur in tropical Australia. Development of appropriate fertiliser management strategies for these soils will be investigated in a Master's Degree program which will be undertaken by one of the Vietnamese project staff following the award of a John Allwright Fellowship for study in 2006–2007.

Australia:

A draft SCAMP manual has been produced detailing the measurement, interpretation and management implications of key soil properties grouped into categories of water and climate constraints, soil pH and acidity constraints, cation constraints, clay fraction constraints, landscape constraints, and soil structural constraints. This manual will be the basis of the training workshop to be held for agricultural extensionists in Vietnam.

The inclusion of a simple soil water partitioning model into SCAMP has allowed identification of the major pathway of water movement (runoff, ponding or drainage) for any soil, based on its drainage and permeability ratings. This information has been used to produce a map of the major pathways of water movement in soils of the Wet Tropical Coast of Queensland. This output will be enhanced by further programming that will link this dominant water movement pathway with timing and placement method of fertiliser application to assess the risk of off-site nutrient movement and denitrification.

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

Overseas Collaborating Countries	Laos, Thailand, Vietnam
Commissioned Organisation	World Vision Australia, Australia
Project Leader	Mr Jonathon Treagust Phone: 03-9287 2509 Fax: 03 92872377 Email: jonathan.treagust@worldvision.com.au
Collaborating Institutions	World Vision of Vietnam, Vietnam Laos World Vision Foundation, Laos World Vision Foundation of Thailand, Thailand Queensland Department of Primary Industries and Fisheries, Australia
Project Budget	\$1,352,769
Project Duration	01/01/2001 to 31/12/2007 (Project extended from 01/01/2004 to 31/12/2007)
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

Increasing the impact of ACIAR project results has been furthered through a partnership with World Vision (WV) projects where provision of technologies arising from ACIAR projects can further agricultural productivity. ACIAR entered into a Memorandum of Understanding (MoU) with World Vision for this purpose in February 2000, and this project comprises some of the major collaborative activities in Southeast Asia under this MoU. This project consists of a set of six collaborative sub-projects between ACIAR and WV in Laos, Thailand and Vietnam. Results from a mature or completed ACIAR project activity that are suitable for farmer-level extension are integrated into an active WV project in particular provinces of the three countries.

In Thailand three subprojects are addressing agricultural productivity and impacts; firstly the use of chemicals in vegetable production and specifically preventing chemical runoff and pollution. A second sub-project is improving fish feeds for aquaculture using locally available ingredients. Finally the third sub-project is introducing improvements applicable to growing low-chill temperate stone fruits. The single Laos sub-project is seeking to introduce improved crop options by boosting wet season rice production and utilising other crops in the dry season. Two Vietnamese components—*Rodent Control in Rice Crops Using IPM Techniques* and *Improvement of Soil Fertility in Bac Binh District, Binh Thuan Province, Vietnam*—utilise technologies developed in several current or completed ACIAR projects to assist in the 'technical underpinning' of a larger WV rural development project in Binh Thuan province of southern Vietnam.

Project progress

Year 6 (01/01/2006–31/12/2006)

Since the beginning of 2004, fish farming cooperatives have been established in Surin and Udon Thani provinces, respectively. From both provinces, three fish feed recipes were trialled and developed using a mixture of crushed fish, soy starch, sugar starch, fine bran, free mixer and corn. The recipes have 30%, 25% and 18% protein and are used to supply members of fish raising groups within the target areas. To improve fish feed production, a solar drying facility was constructed at the Kok Sa-ard Sub-district Centre for Development of Sustainable Economy in Prasat District, Surin Province. Solar heat coming through the transparent glass cover of the house minimises the humidity of feeds and accelerates the drying process.

Four nursery ponds have been established in Udon Thani Province for catfish and cross-sex tilapia fingerling raising. Sex-transformed nil tilapia have been successfully bred using a controlled process of breeding, testosterone feeding and rearing in earth ponds; 50,000 cross-sex tilapia fingerlings were raised successfully in 2005, but the results could not be replicated in Surin Province because of the drought.

In both provinces, farmer participants have been trained in techniques and procedures of fish-raising, from identifying the right location to digging and preparing ponds, selecting fish breeds and fish raising itself. Training has occurred in both earth ponds and plastic lined ponds which are more drought resistance. During the January to June 2006 period, 30 new households took up fish farming and ponds were dug for a further 210 families. These families will be supplied with “Big Aui” breed catfish, once there is sufficient rain. The project also introduced the idea of supplementary planting around the pond sites with high value crops such as chillies, ginger, lemon grass, banana, lemons, coconut and mango. The project has continued with fish processing training, for value added fish products.

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

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Department of Primary Industries, Victoria, Australia
Project Leader	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 disconnection between project outcomes and the public demand for outcomes to link with development 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 in 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 (initially for DPIV, later for MARD).

Project progress

Year 2 (01/07/2005–30/06/2006)

The project is focused on enhancing evaluation efforts both in Department of Primary Industries, Victoria (DPI) and in Vietnam, in the Ministry of Agricultural and Rural Development (MARD). The project has two streams of work:

- to develop evaluation procedures for agricultural Research and Development in MARD.
- to develop a procedure for evaluating complex concepts, with science capability in 'Our Rural Landscapes' (ORL) as the study case, initially for use in DPI, with later application, where appropriate, to R & D in MARD.

In relation to the first stream of work, a number of key activities have been successfully undertaken including:

- Further training has been delivered to the Vietnamese Evaluation officers in Vietnam. This has been undertaken by the DPI Project Leader, who used this training to reinforce key evaluation methodologies delivered in the initial training phases.
- The case studies identified in the first year have been undertaken with significant learnings identified by the MARD Evaluation Officers. Changes in the approaches to the evaluation have been suggested by the MARD Evaluation team and will be implemented in the next case studies.
- Significantly, the MARD Evaluation officers have established the requirement and desire to deliver evaluation training further across MARD in the future. The development of a training package for delivery in Vietnam is under way, and cooperative review of the training course will be undertaken by MARD and DPI evaluation staff. The delivery of 'Train The Trainer' programs has been scheduled for the third year of the project and will be delivered by specialist evaluation and training consultants. This will be supported by a follow-up visit to Vietnam by DPI evaluation staff early in Year 3 of the project.

The loss of the Australian Youth Ambassador working in MARD has had an impact on the close working relationship that had developed by having strong evaluation leadership in MARD. A long distance working partnership is now developing between the MARD and the DPI Evaluation staff members.

Pleasing progress has also been made in relation to the second work stream. Through the delivery of the Concept Mapping Workshops, a series of indicators were generated, these were mapped against the Science Capability domains identified through the research process. Using the Australian Business Excellence Framework (ABEF) as a guide, a Science Capability Framework (SCF) has been developed. The SCF has been trialled on two occasions, with modifications and improvements made from test results. A final version will be rolled out in a broader context in the first half of Year 3.

There were a number of challenging aspects of the concept mapping which suggest that undertaking the Concept Mapping workshops in Vietnam would be problematic. The consultant engaged to undertake the concept mapping, amongst the most experienced in Australia, failed to deliver the outcomes in a timely manner and in a format that allows for full and proper use in the project. Due to the structure of MARD, and the cultural construct of not critiquing others in the organisation, concept mapping may not be the most appropriate method of workshoping with staff to determine indicators of science capability. Our current experience is that this approach is not providing the benefits hoped for and is not recommended for use in Vietnam.

The Vietnamese MARD officers have reviewed the SCF and are prepared to work on the existing indicators and methodology around the SCF to produce a framework that suits the MARD environment. This will be developed further during the year.

Monitoring and evaluation has been embraced by MARD and now has an allocated and dedicated budget of 3% of the total National R&D Budget. A briefing paper titled, 'Current situation of evaluation of research & development projects in the Agriculture sector in Vietnam' outlines this organisational approach now being undertaken by Vietnam.

The Evaluation Model developed by the project is now being implemented and is an effective use in MARD's R&D projects.

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

Overseas Collaborating Countries	Indonesia, Vietnam
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Project Leader	Dr Peter Roebeling Phone: 07 4753 8586 Fax: 07 4753 8600 Email: peter.roebeling@csiro.au
Collaborating Institutions	World Vision of Vietnam, Vietnam Plant Protection Department, Vietnam International Rice Research Institute, Philippines 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

Rodent pests are one of the main causes of rice losses throughout Asia. In Indonesia (number one pest) and Vietnam (in top three) preharvest losses are a chronic problem, often resulting in chemical or poison use by farmers. Despite these approaches farmers have indicated that rodents are the problem they have the least control of. Past ACIAR research developed integrated management approaches that target rodent population cycles and significantly reduce rice losses. Work with World Vision in Vietnam has helped refine these approaches at the village level, and provided insights into extending the approach in such setting. This will now be continued in Indonesia and Vietnam's lowland irrigated rice growing areas.

Project progress

First progress report due in 2007.

AH/1998/054: Poverty alleviation and food security through improving the sweet potato–pig systems in Indonesia and Vietnam

Overseas Collaborating Countries	Indonesia, Vietnam
Commissioned Organisation	International Potato Center, Indonesia
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Collaborating Institutions	Balai Penelitian Tanaman Kacang-Kacangan dan Umbi-Umbian (Balitkabi), Indonesia National Institute of Animal Husbandry, Vietnam South Australian Research and Development Institute, Australia Food Crop Research Institute, Vietnam Dinas Peternakan, Indonesia Research Institute for Animal Production, Indonesia
Project Budget	\$1,252,608
Project Duration	01/01/2001 to 30/12/2006 (Project extended from 01/01/2004 to 30/12/2006)
ACIAR Research Program Manager	Dr Peter Rolfe

Project background and objectives

In Papua (Indonesia) and Papua New Guinea (the western and eastern components of the island of New Guinea) food shortages and malnutrition continue to be major problems, especially in the mountain areas where sweet potato (SP) is the principal staple food. Sweet potato is also the main feed source for pigs, which are raised throughout the island. Pigs are an integral part of the culture and political organisation of many New Guinea tribes; pork is a significant protein source for local people and is in high demand as a traded commodity.

Cash income has become increasingly important in the two regions with the penetration of regional and national markets, and pigs offer a good opportunity for income generation. However, the existing SP-pig systems exhibit several problems, notably low fertility and slow growth in pigs, which may be caused by unbalanced and erratic feeding regimes and health problems. Using an approach that is sensitive to the cultural role of these systems, it is proposed that technical interventions can be made through introduction of novel SP varieties and improvements to pig-raising management, leading to better food and feed productivity and positive benefits on family nutrition and income.

The project aims to assess, characterise and analyse the existing human–SP–pig production systems in Papua within the overall household economy, in order to understand types of systems, their relative importance and their major constraints. Another objective was to improve SP-based production and staple food and feed supplies for both Papua and Vietnam. A further objective was to improve the efficiency of indigenous, integrated pig-raising systems in Papua.

Project progress

Year 5 (01/01/2005–31/12/2005)

A series of multi-location trials have been conducted across Indonesia to collect data required for registration of seven new clones of sweetpotato (SP) bred during the life of the project. The multiplication of planting material will be completed early in 2006, along with registration of the new clones and dissemination of the planting material.

Feeding trials are continuing to evaluate modified diets based on SP tubers and vines. The basic diet contains ensilaged SP vines and tubers supplemented with a range of locally grown crops and herbage to increase the protein content of the base diet. These include corn, three species of pasture grasses [Sundaleka (*Puerasia cephaloides*) Wurikaka (*Centrosema* sp.) and Jirikpuruk (*Calopogonium* sp.)] and two species of fodder trees [Dadap (*Erythrina variegata*), Gamal (*Gliricidia sepium*)], plus vegetables in season. All diets are supplemented with salt and chopped banana trunks. Parasite-free pigs fed these diets are growing 3–6 times faster than parasite-free pigs fed only on the traditional diet of raw SP tubers and vines.

The possibility of supplementing diets with fish, using Nile tilapia (*Oreochromis niloticus*), is being investigated, but these trials will not be completed until 2006.

A rotational foraging system, designed to control internal parasites and restrict the pig's access to toxic plants and human and dog faeces in the traditional family compound has been developed, but is relatively dependent on good seasonal rains. The pigs are housed overnight and allowed to forage during the day in small paddocks (lalekens) and it is planned to use the fodder trees for live fences.

A series of experiments aimed at improving reproductive performance in sows by improving nutrition, housing and management is continuing.

Training of collaborating farmers and scientific and technical staff from local institutions has also continued. All farmers have been trained in preparing diets, feeding pigs, ensilaging SP tubers and vines, planting and growing pastures and fodder trees, and examining dead pigs.

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

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Commissioned Organisation	International Rice Research Institute, Philippines
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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 affects 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 2 (1/1/2005–31/12/2005)

For this year, extensive surveys of 800 farming households (with and without migrants) in Thailand, Vietnam, Philippines and 635 households in Australia were conducted to assess the effects and impacts of family migration/off farm employment on agricultural productivity, farm efficiency, welfare, and the changing roles of women at the household, farm and local level.

Data collection, editing, entry in the computer and preliminary tables were completed in Vietnam and the Philippines. Data editing and data entry is partially completed in Thailand and Australia (75% completed). In-depth surveys of 240 households in Philippines, Thailand, Vietnam and Australia were also conducted to examine perceptions on migration, decision-making, changes in gender roles, source of information in rice farming, trainings attended, participation in rice farming possible interventions and constraints and opportunities. Focus group discussions (FGDs) were also conducted with women farmers in the Philippines, Thailand, Vietnam and Australia to identify the factors that constrain or support the adoption and diffusion of technologies they face in agriculture due to male out-migration.

In Northeast Thailand, the work burden of female family members in rice production increased. They complained of high expenditures on herbicides due to high density of weeds, especially in direct-seeded plots. They also have problems with snails which damage the young rice seedlings; low yields due to drought and reduction in paddy areas due to increasing area cultivated to other crops (sugar cane, Eucalyptus, cassava). Based on these constraints, the women want to be trained on pest control (insects, snails and weeds) and integrated pest management, production of healthy rice seeds and high-yielding rice varieties which can tolerate drought.

In Vietnam, women took over the responsibilities and work load of men in rice operations such as water management, land preparation, dredging field canals, pest management, pest identification, pesticide spraying, fertiliser application and hauling of paddy sacks. The women complained of lack of capital to pay for hired laborers and cash to buy material inputs since the remittances were small. FGDs in the Philippines, Thailand and Vietnam revealed that women who are left to manage their farms are faced with increasing expenditures in rice production. Thus they want to be trained in increasing input efficiency and reducing costs of inputs. For example in Vietnam, women want to be trained on 3 R's (reduce seeds, pesticides, fertiliser) and to better manage/conserves water. In the Philippines, women want to learn more on estimating the costs and returns of rice production. They also want to have access to seeds for short-duration and drought-tolerant crops which they can grow after rice or between two rice crops.

In Australia, FGDs revealed that most farming families have at least one member who works off-farm. Both men & women work off-farm, but there is a higher percentage of women working off-farm. Men mostly do the farm work while women work off-farm to supplement household income. But women also work on the farm. The driving forces for off-farm work and/or work-related migration are to supplement household income, social reasons and isolation issues. The effects of off-farm and non-farm work on agricultural production are: a) additional (higher) household income, women feel they are contributing to household finances and leading to empowerment (i.e. increased participation in decision-making in the household and in the farm).

As more and more women are getting off-farm work (where there is employment) the men, who weren't that way inclined before, are slowly being trained in the traditional female-dominated roles. Men are beginning to realise that women are sometimes the ones saving their livelihood and the significant contribution they make, so farming is definitely becoming more and more a joint effort, with roles constantly being re-evaluated. The major constraints women & their families face when looking for/undertaking off-farm work are: lack of employment opportunities, tyranny of distance, low wages, high travel cost, lack of services (e.g., health, childcare, education) and isolation. The opportunities are: harnessing women's skills, revitalising communities by providing opportunities for off-farm work, opportunities for value adding, attracting youth back to the countryside, and stimulating business in rural communities. During the FGDs, women identified training in leadership programs as an area of capacity-building for women in farms.

To monitor the progress of the project activities, two meetings were conducted. During the first meeting, training on statistical and multivariate analysis was conducted in Social Sciences Division, March 30–June 3. Training on data analysis (econometric analysis) of 800 household surveys was conducted during the 2nd meeting held this year at Curtin University of Technology, Muresk, Perth, Australia on 30 August 2006 by Dr. Fay Rola-Rubzen. Econometric analysis focused on measuring technical efficiency, production analysis and determinants of migration.

Concluded projects

1 July 2005 to 30 June 2006

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ADP/1997/092: Impacts of alternative policy options on the agricultural sector in Vietnam

Overseas Collaborating Countries	Vietnam
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Collaborating Institutions	International Rice Research Institute, Social Sciences Division, Philippines Hanoi Agricultural University, Faculty of Economics and Rural Development, Vietnam
Project Budget	\$810,955
Project Duration	01/07/1999 to 31/03/2006 (Project extended from 01/01/2003 to 31/03/2006)
ACIAR Research Program Manager	Dr Ray Trewin

Project background and objectives

Until 1980, the agricultural sector in Vietnam was collectivised. Most land was cooperatively used, and only 5% was left for individual household use. Farm decisions were made by the central government, which set areas and targets for each of the crops produced by the cooperatives which ran the farms. There was strict control over what farmers could do.

As a consequence of this system, rice production fell short of population growth, leading to serious food shortages. Since 1981, the government has been implementing economic reforms to 'decollectivise' agriculture. These new policies have had considerable effect, and Vietnam is self-sufficient in rice and has become the world's third largest exporter.

However, the impacts of the new policies at the farm level, on factors such as household incomes, land use, credit provision and taxation, are important questions that have had little investigation.

One of the reasons is that Vietnam lacks key personnel with experience in policy design and analysis under a market-orientated economy. However, Australian agricultural economists have considerable expertise in resolving the socio-economic problems that arise during the development process.

Accordingly, this project will use Australian experience to assess the impacts of the new government policies on land use in the agricultural sector during the transformation to a market-based economy. In the process, it will deliberately provide opportunities for teaching Vietnamese staff and researchers to develop their skills in agricultural policy research, formulation and analysis.

The main aims are to assess the impacts of the Vietnamese government's new policies on agriculture and to provide economic models suitable for analysing policy reforms.

Project outcomes

The project outcomes can be considered in three categories:

- capacity development
- a variety of documented policy-oriented models
- research publications with a policy focus

The following list highlights the major project outputs.

Six policy analysis training courses were held, each of approximately five days—four funded within the ACIAR project (135 participants) and two funded by the associated CARD project (52 participants). The training provided new perspectives on quantitative policy analysis, enhanced computer skills, upgraded analytical capacities, provided new teaching materials and encouraged exchange of ideas between staff of the various institutions. Participants came from Hanoi Agricultural University (HAU), various departments within the Ministry of Agricultural and Rural Development (MARD), and other universities and institutions in northern, central and southern Vietnam.

A substantial amount of the training course material on quantitative policy analysis was translated into Vietnamese then made available as hardcopy and on CD-ROM and widely distributed. Training course material included a range of documented models suitable for teaching techniques for quantitative policy analysis.

The comprehensive household survey of 400 farm households in four provinces (Ha Tay, Yen Bai, Binh Duong and Can Tho), completed over two successive years 2001 and 2002, resulted in a large and rich database of land holdings and land use, agricultural production at the household and plot level, labour and credit use, as well as data on farm and off-farm income.

Two successful international workshops were held in conjunction with the project. The first was held at the University of Sydney in November 2002, on the topic 'Land Use in Vietnam: Policy Issues and Research'. A final project workshop, attended by a number of senior policy makers, academics and officials of non-government organisations, was held in Hanoi in February 2004, on the topic 'Land Policy and Agricultural Development in Vietnam'. Project team members presented papers on topics including land fragmentation, land consolidation, the market for land-use rights, land-use flexibility, farm incomes and farm size, price policies, supportive policies and credit use; and a number of papers were also given by external presenters.

An interview with 10 senior Vietnamese policymakers was conducted in November 2003. The specific aim of this work was to assess the attitudes of policymakers to current and further land policy changes, and their attitudes to the pace of change and the market for land use rights.

Publications from the project to date include two refereed journal articles, two consultants' reports, four project reports to ACIAR, four project discussion papers (on the topics of Land Use Flexibility, Land Consolidation and Accumulation, Tax and Credit Policies and Agricultural Land Use, and Input and Output Price Policies), nine conference papers, and numerous workshop and working papers. Further papers will be submitted for journal publication in the near future.

A set of four policy briefs was prepared for distribution at the final project workshop. Topics of the policy briefs were:

- The value of agricultural land and land-use rights in Vietnam
- Land fragmentation in north Vietnam
- Interest rate policy changes
- Taxes and agricultural land use

CIM/1995/130: Soybean variety adaptation and improvement in Vietnam and Australia

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	CSIRO Plant Industry, Australia
Project Leader	Dr Andrew James Phone: 07 32142278 Fax: 07 3214 2730 Email: andrew.james@pi.csiro.au
Collaborating Institutions	Vietnam Agricultural Science Institute, Vietnam Institute of Agricultural Sciences of South Vietnam, Vietnam Thai Nguyen University, Vietnam James Cook University, Australia CSIRO Plant Industry, Australia Hanoi Agricultural University, Vietnam
Project Budget	\$913,408
Project Duration	01/07/1999 to 30/06/2006 (Project extended from 01/07/2002 to 30/06/2006)
ACIAR Research Program Manager	Dr Paul Fox

Project background and objectives

Productivity of soybeans in Asia, and particularly Vietnam, is low compared with elsewhere in the world. Vietnam's average yields are 1t/ha compared with 1.3 t/ha in Thailand, 1.75 t/ha in Brazil and 2.25 t/ha in the USA. The low productivity is a problem because Vietnam needs more soybeans to satisfy a growing demand for stockfeed and to improve the nutrition of the human population.

The reasons for poor production in Vietnam have been clearly identified. One of the most significant is the fact that the varieties grown in summer have a growing period too short to produce the maximum yield possible for the season. The high seasonal rainfall usually occur when crops are maturing and this causes poor seed quality. In addition, these poorly-adapted varieties are grown at low densities to reduce the problem of lodging (plants falling or bending and becoming tangled).

Moreover, soybean is invariably treated as secondary to rice, and so receives less research attention, less fertiliser input, and less effort at insect control. This is made worse by the existing poor yields. It simply does not appear worthwhile to invest in a crop that gives poor financial returns. For this reason, soybean is grown using natural rainfall, and short-duration varieties that make use of this are chosen. These varieties naturally have a low yield potential. Higher-yielding varieties, better suited to the conditions in the growing areas of Vietnam, are seen as one of the main ways of solving this problem. At the same time, improved varieties and knowledge are likely to benefit the small soybean-growing operation in Australia and expand the experience of the Australian project team in a previous soybean improvement project in Thailand.

The project aims to enhance the yield and quality of soybeans in Vietnam and Australia by developing suitable cultivars for immediate use by growers, along with improved agronomic management methods.

Project outcomes

This project connected CSIRO Tropical Agriculture/Plant Industry and James Cook University in Australia formally with the Vietnam Agricultural Sciences Institute, the Institute of Agricultural Science, Thai Nguyen University of Agriculture and Forestry, also informally with the Hanoi #2 Agricultural University, the Oil Plant Institute and Can Tho University in Vietnam.

The thrust in Vietnam was to improve varieties and production methods for summer soybean production in the northern hill and mountain regions—the source of more than 40% of national production in the Red River Delta (which produces about 20% of the crop, mostly in winter) and in the upland regions of southern Vietnam (which produces about 20%).

There were several key elements to the project. The first was to introduce and evaluate elite varieties from the Australian program for yield and adaptation in Vietnam. Concurrently, physiological and agronomic research was undertaken to explore and where possible to minimise limitations to improving adaptation and increasing yield in Vietnam. The research in Australia complemented that in Vietnam, with applied varietal improvement emphasis on tropical adaptation, tolerance to weathering and food quality attributes. Basic research focused on strategies to broaden the gene pool, especially for tolerance to environmental stresses and use of the 'long juvenile' trait to extend duration without increasing photoperiod sensitivity.

The use of extreme-short duration varieties was confirmed as a key limitation to yield in the north of Vietnam. Hitherto, short duration has been necessary to achieve the low day-length sensitivity necessary for one variety to be adapted to the spring, summer and winter cropping seasons. The requirement for one variety to be reasonably adapted to all three cropping seasons was in turn necessary to ensure supplies of fresh planting seed, because of the short time that soybean seed remains viable under local conditions.

During the project, varieties were introduced to Vietnam with medium duration, but with appropriate day-length sensitivity that enabled successful cropping in all three seasons. The combination of varieties with high yield potential and medium duration led to increases in yield over that of check varieties of up to 98, 34 and 49% in the spring, summer and winter seasons, respectively. As a result of these findings, it is likely that one or more lines introduced through the project will be released for commercial production in Vietnam.

The saturated soil culture technique for irrigation of soybean and intercropping soybean with paddy rice was also introduced and tested in the lowland conditions of the Red River Delta. Yield increased by up to 250 per cent through the combination of this technology with introduced varieties with higher yield potential.

The research in Australia identified and introduced to the breeding program new sources of tolerances to cold, drought and pre-harvest weathering of grain. In a linkage with the national breeding program in Australia, a new tropical variety, YY, was released for commercial production. New technologies to identify genes responsible for drought response and for culinary quality were also developed. For the first time, genetic material from the wild perennial relatives was introduced into soybean through somatic hybridisation.

Key outputs from the project have therefore been improved varieties and agronomic management, enhanced understanding of constraints to wider adaptation and higher yields, and new techniques for enhancing the germplasm base available to breeders. In addition to the direct benefits from the project to both the Vietnamese and Australian researchers, the skills base of the Vietnamese researchers was improved through four short-term visits and one long-term training visit to Australia, and the training of several postgraduate research students in Vietnamese universities. In addition, the project facilitated applications that appear likely to enable two project staff to come to Australia and one to the USA for higher degree studies.

FIS/2001/013: Culture-based and capture fisheries development and management in reservoirs in Vietnam

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	Deakin University, School of Aquatic Science and Natural Resource Management, Australia
Project Leader	Professor Sena De Silva Phone: 03 5563 3527 Fax: 03 5563 3462 Email: sena@deakin.edu.au
Collaborating Institutions	University of Agriculture and Forestry, Vietnam Department of Agriculture & Rural Industries, Fisheries Division, Vietnam Victorian Marine and Freshwater Research Institute, Australia Research Institute for Aquaculture No. 3, Vietnam Research Institute for Aquaculture No. 1, Vietnam
Project Budget	\$477,600
Project Duration	01/01/2002 to 31/12/2005
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Vietnam's reservoirs are a source of livelihood for many people living around them, and often these communities include displaced people and ethnic groups who tend to be the poorer sectors of the community. Two types of fishery are involved: culture-based fishery in small, farmer-managed reservoirs and capture fishery in medium and large reservoirs. The average level of production from Vietnam's reservoir fisheries is among the lowest in Asia, suggesting that their potential is not being realised. Thus, fishery research and development is a priority for the Vietnam Government. The current project builds on the recommendations of an initial study, which found that there is potential to develop culture-based fishery in small reservoirs and that rearing fry to fingerling stage in perennial reservoirs could help to meet seed stock requirements.

In Australia, public waters such as areas of the Murray–Darling Basin have the potential to be used for fisheries and aquaculture, but there is little scientific basis and policy or planning framework for such enterprises.

The main aim of this project is to increase the availability and affordability of fish to the rural poor and to generate livelihood opportunities for communities living near reservoirs, by providing the Vietnam Government with relevant information and advice on how to significantly improve the fish yield from reservoirs.

Project outcomes

Overall, both components of the projects viz. on fisheries management in large reservoirs and culture-based fisheries development in small farmer managed reservoirs were successfully completed, on time and on budget. Apart from the achievements of each of these components, the most significant outcome, to which the project was very much responsible, was a policy adoption by the Government of Vietnam, which includes the incorporation of reservoir fisheries as a strategy to increase fish food production and increase income levels of fishers and farmers through fishery related activities in reservoirs in Vietnam, and also initiate funding of R&D projects on reservoir fisheries. Accordingly, the current 10-year plan for fisheries targets to increase reservoir fisheries production to 250,000 t by 2010, from about 20,000 t currently.

In addition, the project enhanced the research capacity in a key research institution in Vietnam, Research Institute for Aquaculture No. 1, and contributed to the development of a critical mass of researchers on reservoir fisheries, and a dedicated unit thereof in the Institute. The project also increased the dialogue between researchers and farmers, as well as with provincial authorities responsible for development fishery activities, which will contribute to the facilitation of further R & D activities that will impact on reservoir fish production.

Culture-based fisheries in small reservoirs: The research component pertaining to culture-based fisheries was completed successfully in May–June 2005. Based on trials, over two growth cycles, each of 9–10 months duration on 32 water bodies in two provinces in North Vietnam (ThaiNguyen and YenBai) and one in the Central Highland region (DakLak), and in combination with data gathered from a previous small project (FIS/97/68), the criteria that would optimise fish production in farmer-managed small reservoirs were determined. Thus knowledge is now available on best practice approach to culture based fisheries in Vietnam, encompassing the best species combination and ratio, the stocking density and the optimal size at stocking to be utilised for reservoirs in different climatic regions, and in relation to relatively easily measurable water quality characteristics, such as conductivity and chlorophyll a content. As well, the optimal harvesting strategies and marketing chains needed to ensure that farmers obtain the maximum returns have been recommended/developed.

Most of all the findings have been extended, successfully, to other provinces in north Vietnam, through a series of workshops aimed at the potential farming communities. These workshops have established a useful conduit between the researchers and farmers and provincial fishery authorities, and facilitated the uptake of culture-based fishery activities in new areas. In addition, the Provincial Governments of at least two provinces (ThaiNguyen and YenBai), have incorporated culture-based fisheries development as a strategy to increase the income of rural farming communities and contribute to poverty alleviation.

Fisheries management in large reservoirs: A total of 14 large reservoirs, located in the different climatic regions of the country were involved in the study. Where available, historical data on individual fisheries were obtained and supplemented with *in situ* data collection over the period 2003 to 2005. It was evident that the management regimes had changed significantly with economic rationalisation in the early to mid-1990s, and consequently, all subsidies provided by the government had been withdrawn, and the fisheries of the large reservoirs went into a period of disarray. Currently, the reservoir management regimes differ from reservoir to reservoir, and range from complete private management, when water bodies are leased out to fishery agencies through a bidding process, to a system of co-management that involves fishers and a government “backed” fishery agency.

The data obtained suggest that in reservoirs exceeding 700 ha, stocking is not a cost-effective strategy to enhance fish production, and in reservoirs less than 700 ha the stocked species recruit to the fishery, most effectively, two years post-stocking. Based on the data, statistical models were generated showing stocking to yield relationships, which could be used by fishery managers. Detailed studies were conducted on the fishery of two reservoirs (ThacBa and NuiCoc) that included fish faunal composition, gear efficiency, catch curves, catch per unit effort to yield relationships. Based on all this information specific recommendations for each reservoir group, were developed.

The biology and the fishery of the artisanal fishery on the shrimp, *Macrobrachium nipponensis*, little known in Vietnamese waters but which supports the livelihood for a significant number of fishers, living in the vicinity of the reservoirs, was addressed. Based on the available data maximum catch limits and fishing pressure were determined, and this information is expected to help sustain this fishery in the long term. In view of the increasing concerns on impacts of dam-building on biodiversity the study attempted to discern relationship of fish species diversity in relation to a number of reservoir features (size, age, mean depth, shoreline length), including catchment features such as land-use patterns and human population density. Interestingly, the reservoir fish species diversity was significantly and positively correlated to the catchment human population density. Overall, and apart from the specific management measures that have arisen from the study, the project has developed an appreciation, amongst provincial authorities and fishery agencies, of the need for a science-based management strategy on reservoir fisheries to ensure long-term sustainability and optimise the outcomes for human benefit.

FIS/2005/030: Dissemination of findings on the ‘best practise approach’ to culture-based fisheries through a series of workshops in selected developing countries in Asia

Overseas Collaborating Countries	Laos, Thailand, Vietnam
Commissioned Organisation	Network of Aquaculture Centres in Asia Pacific, Thailand
Project Leader	Dr Thuy T. T. Nguyen
Collaborating Institutions	
Project Budget	\$48,740
Project Duration	10/01/2005 to 31/12/2005
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

The objective of this project was to disseminate and share experiences gained through ACIAR projects relating to culturing fish in inland reservoirs. This was achieved through a series of workshops with local fish farmers, aquaculture planners and developers in Bangladesh, Laos PDR and Cambodia. ACIAR projects in Sri Lanka and in Vietnam on reservoir-based aquaculture have been successful in bringing out legislative changes that could stimulate growth. These projects have also been responsible for recognition and incorporation of culture-based fisheries in the fisheries development plans. Culture based fisheries are an effective way of increasing fish food supplies to rural areas, at an affordable price, and provide income to rural farmers, thereby contributing to poverty alleviation.

Project outcomes

This was a development mission for a project proposal on Culture-based fisheries development in Lao PDR, it became FIS/2005/078. The primary objective of the new project is to develop in two provinces of Lao PDR suitable production models—technological package(s)—that can lead to an optimisation of yields from culture-based fisheries (CBF) practices in flood plain depressions and reservoir coves through village community participation.

FST/1994/019: Genetic diversity and propagation of mangroves

Overseas Collaborating Countries	Thailand, Vietnam
Commissioned Organisation	Southern Cross University, Centre for Coastal Management, Australia
Project Leader	Professor Peter Saenger Phone: 02 6620 3631 Fax: 02 6621 2669 Email: psaenger@scu.edu.au
Collaborating Institutions	Royal Forest Department, Thailand Vietnam National University, Vietnam
Project Budget	\$866,940
Project Duration	01/07/1999 to 31/10/2005 (Project extended from 01/07/2004 to 31/10/2005)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Mangrove forests are a well known feature of coastlines in the tropics and subtropics. They are very important in protecting and stabilising coasts in cyclone-prone areas. They act as a nursery for many fish species of economic importance and a habitat for other fauna. They can also be an important resource for local people, providing them with wood and other products. Mangroves are now heavily exploited in many parts of the world. Wood-gathering and fishpond operations are the main threats. Other pressures are mining and mineral extraction, diversion of freshwater (which damages mangrove roots), the development of coastal areas with associated silt and pollution, the construction of channels and harbours, and the disposal of wastes.

About 80 higher plant species, from several different groups, are considered as mangroves. There is thus considerable variety in mangrove forests. This diversity is generally reduced by exploitation or other damaging pressures. Once damaged or destroyed, it is hard to re-establish mangrove forests. The survival rate of seedlings is naturally low, and this difficulty is compounded by a lack of seed availability to establish re-planting programs. It's also important to know what types of mangroves to plant where. If reforestation of degraded mangrove areas is to be successful and appropriate conservation strategies defined, it will be necessary to improve the collection, storage and transport of mangrove germplasm (the seeds) and to understand better the intricacies of mangrove genetics.

Several developing countries have asked ACIAR to help with the problem of obtaining adequate supplies of desirable germplasm to set up mangrove plantations. These requests were the origins of this project.

This project aims to improve our knowledge of the genetic variation existing in selected species of mangroves, and then to produce and disseminate germplasm of high quality varieties. The work is expected to benefit mangrove conservation and reforestation in South and Southeast Asia.

Project outcomes

Mangrove communities have been heavily exploited for their wood, and disturbed by other activities including aquaculture, mining, and disposal of chemical wastes. This project was established with Thailand to undertake molecular biological studies on genetic variation in mangroves, and Vietnam to develop methods for micropropagation of mangrove through tissue culture.

After two and a half years excellent progress was made in achieving the objectives related to the application of DNA marker techniques to the mangrove *Avicennia marina*. This research was conducted at Southern Cross University, and was given a head start when important groundwork for the molecular studies of genetic diversity in this species was initiated and supported by Southern Cross University in 1997. The results have been disseminated in several publications in refereed journals, and have raised important questions about population structure, mating systems and gene flow that are currently being addressed in Australia (*A. marina*) and Thailand (*R. apiculata*). In Thailand, the collaborators have succeeded in establishing new techniques of DNA analysis with support and training from Southern Cross University. The project has thus clearly contributed to building research capacity in Thailand.

Glasshouse trials of *A. marina* from different provenances have shown that plants maintain differences in morphological and growth characters when grown in the same environment. This is an important result as it demonstrates that these traits are genetically determined. It still needs to be determined what characteristics are considered desirable for re-establishment of new plantations in specific locations, and the extent to which these can be sought out in natural populations.

A major aspect of the project has been to develop micropropagation of mangroves using tissue culture techniques. However, it has become evident that mangroves (*A. marina* and *Rhizophora spp.*) do not respond well in tissue culture. Satisfactory progress has been made at Burringbar NSW and Yen Lap, Vietnam, yet much work remains ahead before routine and efficient micropropagation of desirable genotypes can be achieved. The project has received an 18-month extension.

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

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

Project background and objectives

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

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

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

Project outcomes

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

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

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

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

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

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

Community impacts

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

Scientific impacts

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

Capacity impacts

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

LPS/2005/045: Cattle rearing survey in Vietnam

Overseas Collaborating Countries	Vietnam
Commissioned Organisation	World Vision of Vietnam, Vietnam
Project Leader	Mr Andrew Catford Phone: 84 4 771 6230 Fax: 84 4 771 6225 Email: andrew_catford@wvi.org
Collaborating Institutions	
Project Budget	\$13,000
Project Duration	01/06/2004 to 31/12/2004
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

This small research activity was a cattle rearing survey undertaken by World Vision as part of its ongoing collaboration with ACIAR's livestock production program in that country.

LWR/1998/119: Impact of heavy metals on sustainability of fertilisation and waste recycling in peri-urban and intensive agriculture in Southeast Asia

Overseas Collaborating Countries	Thailand, Vietnam
Commissioned Organisation	CSIRO Land and Water, Australia
Project Leader	Dr Mike McLaughlin Phone: 08 8303 8433, Mob: 0409 693 906 Int: +61 409 693 906 Fax: 08 8303 8565 Email: Mike.McLaughlin@csiro.au
Collaborating Institutions	Department of Agriculture, Thailand Asian Vegetable Research and Development Center, Taiwan Nong Lam University, Vietnam National Institute for Soils and Fertilisers, Vietnam Queensland Department of Primary Industries and Fisheries, Australia Department of Natural Resources and Mines, Queensland, Australia Department of Land Development, Thailand
Project Budget	\$1,114,544
Project Duration	01/07/2001 to 31/03/2006 (Project extended from 01/07/2005 to 31/03/2006)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

This project developed out of a growing concern about the contamination of agricultural soils and crops in Southeast Asia and because international importers of produce are using the presence of contaminants as a means to restrict trade from these regions. A preliminary investigation—which examined soil and crop contamination in Malaysia and Thailand—found high concentrations of zinc and copper in vegetables and soils. Results also indicated: that many farmers and agricultural industries are unaware of the contaminants that are present in agricultural inputs such as fertilisers, manures, composts and pesticides; that agricultural inputs generated from municipal wastes, industrial sources and soil replacement materials are used as cheap sources of nutrients on farms; and that the intensive use of fertilisers and wastes in peri-urban agriculture leads to the accumulation of cadmium in certain crops.

Because most of the scientific understanding of the behaviour of contaminants present in the soil and food chain arises from research in temperate climates in developed countries, health and environmental authorities in Southeast Asia need data on which to base guidelines for contaminants in soils and crops.

This project aimed to provide a scientific basis for the protection of Australian and Asian soils from irreversible degradation by heavy metals and metalloids. It aimed to assess the adverse impact that agricultural and industrial practices have on the soil and the crop quality in tropical regions of Southeast Asia and to develop strategies to limit these adverse impacts on agricultural systems and on human health. It also aimed to maximise the benefits and minimise the risks associated with the use of wastes and fertilisers in peri-urban agricultural systems.

Project outcomes

An important project outcome was the upgrade of laboratory facilities in Vietnam for the study of soil and crop contamination, and training of personnel to use these facilities. Other outputs included a database of background concentrations of toxic metals in Vietnamese agricultural soils, the identification of critical concentrations of heavy metals and metalloids in subtropical and tropical soils with regard to toxicity and transfers in the food chain, and new scientific criteria and guidelines that can be used to rank wastes as suitable or unsuitable for continued use in peri-urban agricultural systems in tropical and subtropical regions of Southeast Asia and Australia.

The very positive findings of the final review in 2004 led to a nine-month extension of the project. The objectives of the extension were:

- (1) for the Australian component (CSIRO) of the project to continue providing assistance to Vietnam in order to finalise data sets and to analyse and interpret the data.
- (2) to determine the site histories of representative sites to assist in the interpretation of soil/plant concentrations of heavy metals in locations where unexpectedly high or low values were measured.
- (3) to develop relationships between 'plant-based' and 'soil health' measures of sensitivity to heavy metals for as many soil types as possible.
- (4) to extend technology transfer of information on methods for analysing ecotoxicological data, achieved by conducting two-day workshops in both Ho Chi Minh City and Hanoi.
- (5) to publish a short summary document of the project achievements and the safe and sustainable use of bio-solids in Vietnam.
- (6) to decontaminate the field sites heavily affected with metal salts, especially cadmium, and to dispose of the contaminated soil using internationally accepted methods.

PHT/1998/137: Integrating effective phosphine fumigation practices into grain storage systems in China, Vietnam and Australia

Overseas Collaborating Countries	China, 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
Collaborating Institutions	Zhengzhou Grain College, China State Administration of Grain, China Guangdong Institute of Cereal Science Research, China Postharvest Technology Institute, Vietnam Chengdu Grain Storage Research Institute, China Ministry of Agriculture and Rural Development, Vietnam
Project Budget	\$897,566
Project Duration	01/01/2001 to 31/12/2005 (Project extended from 01/07/2004 to 31/12/2005)
ACIAR Research Program Manager	Dr Greg Johnson

Project background and objectives

Australia (about 25-30 million tonnes), China (495 mt) and Vietnam (30 mt) produce significant grain harvests each year, including rice, wheat, maize and other grains. Each country fumigates about 80 per cent of this grain with phosphine. Due to the combined advantages of low cost, ease of use and acceptance as a residue-free treatment, this fumigant will remain the central component of insect pest management for the foreseeable future in Australia and throughout Asia. However, scientists in an earlier ACIAR project identified resistance in target pests as a threat to the continued viability of this fumigant. It also became apparent that several other factors, in addition to resistance, were contributing to control failures with phosphine.

To ensure the continued viability of phosphine technical innovations to enhance the efficacy of phosphine and the development of management strategies to control several psocid species are needed. These have developed as a major problem in stored grain in China. Psocids have also emerged as a major problem in Australia, and initial work here has shown that resistance to phosphine is an important factor, but ecological aspects may also be important.

This project formulated and verified national fumigation standards for China, Vietnam and Australia, improved fumigation practice in China and Vietnam by undertaking training programs, investigated potential innovations to enhance the efficacy of phosphine fumigation, and determined the key factors preventing effective control of psocids with phosphine. The major intention of the research was to protect and enhance the utility of phosphine as a fumigant for grain and to more fully integrate it into pest management in grain storage systems.

Project outcomes

Objective: To formulate and verify national fumigation standards

National fumigation standards for various storage types, aimed at controlling strongly resistant insects and including best management practice, were established in each participating country. The standards were based on broad surveys of insect populations to identify resistant phenotypes, laboratory characterisation of resistance levels and extensive field trials of proposed protocols.

- National standards for modern grain storages and bag-stack fumigations were established and published by Chinese State Administration of Grain.

- In Australia, research has under-pinned an extensive review of phosphine registration. New registration labels for cylinder-based formulations have already been published and label changes for solid formulation aluminium phosphide are currently being negotiated between APVMA and registrants.
- In Vietnam officers of Plant Protection Department prepared procedures for effective phosphine fumigation and submitted them to MARD for incorporation into the National Fumigation Standard.

Objective: To improve fumigation practice in China and Vietnam by undertaking training programs

China: In 2001 QDPI&F and Grainco staff trained about 40 key scientists and storage managers in safe, effective use of phosphine and in adult education (extension) and implementation techniques. Chinese project participants then conducted training workshops for more than 3500 grain storage personnel with support from the State Administration of Grain.

Vietnam: Early in the project, staff of VIAEP completed a national survey of insect infestation rates and pest management practices undertaken by farmers, cooperatives and central storages in Vietnam, and the potential of fumigation with phosphine. This information was used to develop appropriate extension strategies and provided a baseline for measuring changes seen as a result of the project.

Objective: Decreasing losses to stored food suffered by poor farmers by researching, and extending improved household storage techniques.

Surveys of the farm grain storage system revealed that fumigation with phosphine is, in most cases, not appropriate for farmers because of potential health risks. They therefore realigned their extension and research effort to emphasise other management techniques.

In Vietnam the VIAEPHT project team delivered 11 training courses, each for about 70 farmers, in seven provinces in the north and centre of the country. Topics covered: insect pest detection and damage, results of field trials, use of practical, effective cleaning, drying and storage methods. The team also produced a practical IPM manual for farmers. Experimental trials were set up in farm households and villages to introduce and demonstrate new technologies including storages and grain dryers. This team focused on introducing appropriate improvements to the lives of ethnic minority people living in mountainous regions where postharvest losses are typically 20% and can reach 40%. They trialled drying and storage methods that were affordable and compatible with village lifestyle and successfully reduced insect damage to about 5%.

Objective: To investigate potential innovations to enhance the efficacy of phosphine fumigation

In China scientists at the Chengdu Grain Storage Research Institute defined levels of CO₂ required for control of a wide range of storage pests. They also demonstrated the utility of applying phosphine as a split application and the use of CO₂ to improve the efficacy of phosphine (by limiting sorption).

In Australia researchers at QDPI&F completed extensive experiments and field trials characterising the influence of fumigation temperature, phosphine concentration and exposure period on the effectiveness of phosphine against resistant *Rhyzopertha dominica* and *Sitophilus oryzae*. Resistance to phosphine has also been characterised in *Tribolium castaneum* and *Oryzaephilus surinamensis*—both resistances can be controlled with newly developed protocols.

Phosphine fumigations of grain in bag-stacks and in small bins generally result in exposure of insects to changing concentrations of gas rather than the more constant concentrations experienced in large storages. In Australia, a series of experiments undertaken at QDPI&F showed that the efficacy of changing concentrations of phosphine can be predicted from results from assays using constant concentrations. This result will allow a shortening of fumigation times

Objective: To determine the key factors preventing effective control of psocids with phosphine

Students at Henan University of Technology contributed outstandingly to the knowledge we have of psocid biology, ecology, distribution and resistance to phosphine. This work is a highlight of the project.

CP/2000/002: Development of advanced technologies for germplasm conservation of tropical fruit species

Overseas Collaborating Countries	Malaysia, Philippines, Thailand, Vietnam
Commissioned Organisation	International Plant Genetic Resources Institute, Malaysia
Project Leader	Dr V. Ramanatha Rao Phone: +60 3 89423891 Fax: +60 3 89487655 Email: v.rao@cgiar.org
Collaborating Institutions	Griffith University, Australia Department of Agriculture, Thailand Institute of Agricultural Genetics, Vietnam University of the Philippines at Los Banos, Philippines Universiti Kebangsaan Malaysia, Malaysia
Project Budget	\$746,480
Project Duration	01/01/2003 to 31/12/2005
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

The Asia, Pacific and Oceania region has more than 400 tropical fruit species that can provide income, nutrition, medicine, timber, fuel and livestock feed, only a few of which have been exploited commercially. Tropical fruit species and their wild relatives play an important role in stabilising and sustaining ecosystems, particularly in Asia. Several native species are rapidly approaching extinction; thus, there is an urgent need to conserve this diversity. However, many species of tropical fruit are difficult or impossible to conserve by traditional methods such as seedbanks or field genebanks, and there are currently no efficient, appropriate methods for their long-term, sustainable conservation. New in vitro technologies are therefore needed for conserving tropical fruit species. Such technologies are the subject of this project, which will complement an Asian Development Bank funded project, *Conservation and use of tropical fruit species biodiversity in Asia*, that is being implemented by the International Plant Genetic Resources Institute (IPGRI). The Asian Development Bank project involves 10 countries, including the Asian countries involved in this project.

This project aims to conserve the genetic resources of selected tropical fruits and related species by developing new conservation methods and regeneration strategies, and disseminating these technologies to researchers and others within the Asia, Pacific and Oceania region.

Project outcomes

In this project, conservation techniques were developed for target tropical fruit species such as papaya, mango, Australian native fruits and several varieties of citrus, longan, litchi, *Nephelium* and persimmon. Development of conservation techniques included establishing a micropropagation system, optimising cryopreservation protocols and investigating alternative conservation and regeneration strategies.

Papaya: Protocols for vitrification-based shoot tip cryopreservation were refined and successfully applied to a range of papaya genotypes and to *Vasconcellea pubescens*, a papaya wild relative. Factors that were optimised prior to liquid nitrogen (LN) exposure include age of culture, duration of overnight incubation and duration and temperature of exposure to the cryoprotectant. Post-LN factors that were tested and refined in this project included: duration of exposure to dark incubation; the effect of growth regulators in the culture medium on the rate of recovery of shoots; and rate of growth of plantlets *in vitro*. The effects of cryopreservation protocols on the growth of plants *in vivo* were also evaluated, including large-scale field trials. Papaya somatic embryos were recovered after cryopreservation and work on seed desiccation, germination and storage at a range of temperatures was carried out. It was shown that at any moisture content, seeds can be germinated with gibberelic acid (GA3) treatment or heat shock; the former was more effective. This also shows that papaya seeds may have dormancy right from the beginning. Papaya seeds were stored up to 12 months at a range of moisture contents and a range of temperatures, including cryostorage. Protocols for slow-growth of papaya *in vitro* were developed by modifying a medium previously developed for papaya micro-cutting. Plants were held under normal incubation conditions for 8 to 12 months before transfer.

Mango: Somatic embryogenesis was obtained and substantial progress was made with induction and maintenance of somatic embryos (SE) of mango suspension cultures and protocols for secondary embryogenesis. Successful cryopreservation of SE was obtained by pre-culturing embryo masses (EMs) in sucrose and Plant Vitrification Solution 2 (PVS2). Although 70% recovery was obtained, replication of these results is a major problem; more research is required to optimise the protocol.

Australian native fruits: *Citrus australasica* seeds demonstrated tolerance to desiccation and ultra-low temperatures, and had normal post-cryostorage morphology. Results on seed storage of *C. inodora* and *C. garrawayi* showed that these species have tolerance to desiccation and cryostorage, however reduced seedling vigour was observed. Seeds of both species survived cryopreservation with growth and acclimatization of plants post cryostorage. A micro-propagation protocol was established for three Australian native *Citrus* species (*C. australasica*, *C. inodora* and *C. garrawayi*) that was suitable for mass multiplication and medium-term storage of this valuable germplasm. Somatic embryogenesis protocols were investigated for *C. inodora*, *C. garrawayi* and *C. australasica* using published methods and some media modifications. Embryogenesis was achieved in *C. inodora* and embryogenic tissue has been recovered from cryostorage using an encapsulation-dehydration protocol.

Davidsonia spp.: A micropropagation system was developed through the production of microcuttings *in vitro*. Protocols were developed for shoot and plantlet regeneration via organogenesis from a range of explants of *D. pruriens* and *D. jerseyana*. Preliminary experiments on vitrification and encapsulation-dehydration-based methods for cryopreservation were not successful. Work on organogenesis for *D. johnsonii* is ongoing. Studies indicate that these three species are distinct.

Litchi and longan: Media for litchi and longan micropropagation were developed. Seed desiccation studies of litchi and longan identified optimum desiccation periods. Conservation of longan and litchi can be applied using encapsulation-dehydration technique of shoot tips.

Persimmon: A suitable media was identified for persimmon embryo culture and nodal cutting. Successful cryopreservation of embryonic axes (EA) was obtained through vitrification, but not for shoot tips. These results indicate that vitrification is not suitable for persimmon shoot tips.

Citrus: Optimum desiccation periods were identified for seeds of all the species studied. Protocols for adventitious root formation and regeneration of shoots for *C. hystrix* were developed. Regeneration via somatic (nucellar) embryogenesis was also developed for calamansi (*X Citrofortunella macrocarpa*) and mandarin (*C. reticulata*) using immature and mature seeds. For pummelo (*C. grandis*), callus was induced from juice vesicles and albedo tissues, but somatic embryogenesis and shoot regeneration was observed only in callus from albedo. A regeneration system via somatic embryogenesis was developed for lime using undeveloped ovules (immature seeds). Immature seeds of citron (*C. medica*), limon (*C. limon*) and native lime 'dalayap' (*C. aurantifolia*) showed varying degrees of callus and root formation. An effective slow-growth medium was identified for mandarin (*C. reticulata*).

Cryopreservation of desiccated seeds was studied for calamansi, mandarin, pummelo, native lime, limon and kubot (Philippine native *Citrus* sp.). The feasibility of low-temperature seed storage for short-term conservation of a few citrus species was investigated; storage of desiccated seeds of citron (*C. medica*) and kubot (*Citrus* sp.) could be used for medium-term conservation. For cryopreservation of embryogenic callus using encapsulation-dehydration technique, a suitable pretreatment and desiccation period were identified for *C. reticulata* and *C. sinensis*. For *C. hystrix*, the vitrification method was modified to obtain an acceptable level of survival.

Effects of desiccation and cryopreservation on lime, pummelo, calamansi, kubot, Tai Cat (mandarin type) and calamandarin (*C. reticulata*) were assessed using enzyme systems and no variants were observed. Random amplified polymorphic DNA (RAPD) primers were identified to study the genetic stability of *Citrus* regenerants (still to be tested).

Nephelium: Protocols for adventitious root formation and shoot regeneration were developed. Different steps in the vitrification procedure were studied and optimised. Further modification and study need to be carried out for the survival of shoot tips after cryopreservation. Slow-growth technique has shown potential for short-to-medium-term storage of germplasm. Suitable primers for RAPD have been identified for genetic stability studies on regenerants.

Dissemination of technology

A training course was held in the first year of the project in which participants learned micropropagation, cryopreservation and molecular marker techniques. Three annual meetings have been conducted in which country coordinators had the opportunity to review and consolidate work conducted over the project's three years of implementation. Protocols developed from this project will be documented and distributed. Several publications to facilitate the dissemination of technology were prepared and more are in development.

Projects under development

as at 30 June 2006

Bilateral

ADP/2002/092	Free trade agreements in East Asia—their effects on agricultural trade
ADP/2005/113	WTO accession and structural adjustment implications
CP/2006/066	Improving productivity and fruit quality of sweet persimmon in Vietnam and Australia
CP/2006/081	Technical support facility for commercialisation of protein bait in Northern Vietnam
CP/2006/083	Phosphine fumigation training project
CP/2006/084	Targeting crop protection research and development (R&D) towards social change amongst ethnic minority communities in Central Vietnam
CP/2006/112	Enhancing the role of women in indigenous vegetable production, promotion and consumption in Vietnam
CP/2006/113	Scoping studies to review the role of women and assess constraints in the production of indigenous Vietnamese vegetables
FIS/2005/114	Building mollusc hatchery production capacity in Vietnam and Australia
FIS/2005/115	Transferring existing knowledge from ACIAR projects in other countries to Vietnam, particularly in the area of shrimp health
FIS/2006/098	Mud crab aquaculture in Vietnam: feeds and feeding strategies for industry growth
FIS/2006/099	Increasing uptake of aquaculture nutrition research in Vietnam
FIS/2006/140	Mudcrabs Indonesia Vietnam III
FST/2006/085	Timber processing opportunities with Melaleuca and Mangrove in Vietnam
FST/2006/087	Improved site management for fast-growing plantations in Vietnam
LPS/2006/069	Development of smallholder cattle production in the south eastern region of Vietnam
LWR/2003/035	Improving the utilisation of water and soil resources for tree crop production in coastal areas of Vietnam and New South Wales
PLIA/2005/013	PLIA Projects—balance available
PLIA/2005/061	Economic analysis of Vietnam's aquaculture industry

Multilateral

ADP/2005/063	Successful smallholder pig producers in an adjusting Vietnam market
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- ADP/2006/145 Impact of changing agricultural markets on small-farm participation and poverty:
Cases from India, Vietnam, and Indonesia
- FIS/2006/126 Developing pond aquaculture for sandfish in Asia-pacific
- PLIA/2003/063 Increasing the effective use of livestock research for development in SE Asia

Vietnam consultations

12–13 February 2004

Indicative priorities for ACIAR projects in Vietnam

Priorities for collaborative agricultural research between ACIAR and Vietnam were discussed on 12–13 February 2004 at a consultation with representatives of relevant Vietnamese Government Ministries, departments and research organisations. These priorities are not to be considered as officially sanctioned priorities of the Government of Vietnam. They are priorities expressed by participants at a consultation at a particular point in time. ACIAR will use them as a framework when assessing proposals for collaborative projects to be supported by ACIAR, subject to further advice and information from Vietnam.

The ACIAR portfolio emphasises selected areas within the disciplines of agricultural development policy, crop protection and postharvest technologies, fisheries, forestry and aspects of animal production and land and water resources management. Researchers intending to seek ACIAR support for collaborative research projects with Vietnamese counterparts should, in the first instance, approach the relevant ACIAR Research Program Manager.

Overarching emphases include research to assist 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 emphasise sustainable cultivation systems for poor sandy soils in central Vietnam and acid sulfate soils in the Mekong Delta.

While much of ACIAR's program will remain based in greater Ho Chi Minh City and Hanoi because of the location of research institutes, the national relevance of the outputs of much of the research and the need to deliver the results of policy research to government stakeholders, there will be an increased emphasis on central Vietnam, particularly central coastal provinces. There will also be an increased emphasis on implementation of the results of earlier ACIAR-funded research including developing manuals and other communication materials.

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, including: experimental design and statistical analysis; research management; research monitoring and evaluation; scientific proposal/grant writing and project design; biotechnology (particularly use of molecular markers); writing for scientific, extension, farmer and government audiences; and collection and analysis of market information. Specific project priorities are listed under ACIAR program areas:

Agricultural Economics and Development Policy

- Policy options for optimising future market-oriented crop (particularly rice) production in Vietnam, including understanding of the role of stakeholders in policy, production and markets
- Options for development of small-scale agro-enterprises in rural areas, including institutional and market chain analysis
- Assessment of and industry planning for possible impacts of trade agreements, particularly on the fisheries sector
- Policy options for cooperatives in agricultural (particularly fisheries) production and marketing systems to deliver improved and more secure returns to smallholders

Animal Sciences

- Smallholder pig production systems including nutrition, housing, health and meeting market requirements
- Smallholder production of beef and small ruminants within crop–livestock systems including nutrition, genotype assessment and management
- Incentives and regulatory issues for improved animal waste management in peri-urban areas

Fisheries

- Cost-effective and environmentally-friendly aquaculture feeds, with greater use of locally available nutrient sources
- Profitable 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, with particular attention to shrimp health

Crop Protection and Postharvest Technology

- Enhancement of disease and pest diagnosis and management for perennial crops of Central Vietnam
- Integration of practical fruit fly strategies with the management of other insect pests
- Development of pest survey manuals, compendia and databases to enhance quarantine capabilities
- Reducing postharvest losses and ensuring quality in smallholder systems for fruit, grains, legumes, animal feed and coffee
- Interventions to enhance the food safety and marketability of horticultural crops, particularly through supply chain analysis of tropical fruit

Forestry and natural resource management

- Development of technologies for fast-growing forest plantations for high and sustainable productivity, growing especially *Eucalyptus*, *Acacia* and *Pinus*, on degraded soils in northern and southern Vietnam
- Improvement of plantation wood processing efficiency, especially for small eucalypts and acacias through small-scale sawing, drying, preservation, and use of composites
- Use of indigenous tree species with high timber and non-timber forest product values and for rehabilitation of natural forests and conservation of biodiversity
- Sustainable cultivation techniques, including recycling of organic matter, to develop agriculture and agro-forestry on poor sandy soils in central coastal Vietnam
- Development of land-use practices to minimise the negative impacts to the environment on sandy and acid sulfate areas

ACIAR publications

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

Impact Assessment Series Reports

- 01 Control of Newcastle disease in village chickens
- 17 Breeding and feeding pigs in Australia and Vietnam
- 19 Measuring the poverty impact of ACIAR projects: a broad framework
- 21 Improving methods in diagnosis, epidemiology, and information management of foot and mouth disease in SE Asia
- 24 Assessment of rodent control projects in Vietnam: adoption and impact
- 27 Acacia hybrids in Vietnam
- 35 Review of the returns to ACIAR's bilateral R&D investments
- 36 Impacts of mud crab hatchery technology in Vietnam
- 39 Benefits to Australia from ACIAR-funded research

Monographs

- 32 Working with mycorrhizas in forestry and agriculture
- 48 Nutrient disorders of sweet potato
- 54 Survey toolbox for livestock diseases: practical techniques for developing countries
- 57 Haemorrhagic septicaemia
- 58 Understanding animal health in Southeast Asia
- 59 Ecologically-based rodent management
- 62 Developing forage technologies with smallholder farmers: how to select the best varieties to offer farmers in Southeast Asia (available from CIAT: www.ciat.cgiar.org/asia) (Vietnamese edition available)
- 74 Nutrient disorders in plantation eucalypts
- 82 Controlling Newcastle disease in village chickens: a field manual
- 83 How to unravel and solve soil fertility problems*
- 86 Controlling Newcastle disease in village chickens: a training manual
- 87 Controlling Newcastle disease in village chickens: a laboratory manual
- 88 Developing forage technologies with smallholder farmers: How to grow, manage and use forages (Vietnamese edition available)
- 94 Survey toolbox for aquatic animal diseases: a practical manual and software package
- 96 Rats, mice and people: rodent biology and management
- 97 Effects of globalisation and economic development on the Asian livestock sector
- 98 Domestication of *Chukrasia*
- 99 Developing agricultural solutions with smallholder farmers (Vietnamese edition available)
- 100 Field methods for rodent studies in Asia and the Indo Pacific
- 110 Advances in grouper aquaculture
- 113 Worm control for small ruminants in tropical Asia
- 114 Diversity and management of *Phytophthora* in Southeast Asia
- 115 Nitrogen fixation in acacias
- 117 Selecting safer pesticides
- 119 Guidelines for surveillance for plant pests in Asia and the Pacific
- 120 Better-practice approaches for culture-based fisheries development in Asia
- 121 Planters and their components: types, attributes, functional requirements, classification and description
- 123 Agricultural development and land policy in Vietnam

Proceedings

- 31 Bacterial wilt of groundnut
- 45 Bacterial wilt
- 50 Postharvest handling of tropical fruit
- 58 Development of postharvest handling technology for tropical tree fruits
- 60 Postharvest technology in Vietnam
- 61 Agricultural impacts on groundwater quality
- 63 Matching trees and sites
- 66 Bluetongue diseases in the Asia-Pacific Region
- 68 Exploring approaches to research in the animal sciences in Vietnam
- 71 Grain drying in Asia
- 74 Sustainable parasite control in small ruminants
- 77 Breeding strategies for rainfed lowland rice in drought-prone environments
- 81 Disease control and storage life extension of fruit
- 85 Seeking agricultural produce free of pesticide residues
- 86 *Leucaena*: adaption, quality and farming systems
- 89 Elimination of aflatoxin contamination in peanut
- 94 Classical swine fever and emerging diseases in Southeast Asia
- 95 Working with farmers: the key to adoption of forage technologies
- 97 *Hypsipyla* shoot borers in Meliaceae
- 98 Reservoir and culture-based fisheries: biology and management
- 100 Quality assurance in agricultural produce
- 101 Increased lowland rice production in the Mekong region
- 103 SADC planning workshop on Newcastle disease control in village chickens
- 105 Postharvest handling of fresh vegetables
- 106 Water policy reform: lessons from Asia and Australia
- 108 Development strategies for genetic evaluation for beef production in developing countries
- 109 Inoculants and nitrogen fixation of legumes in Vietnam
- 111 Eucalypts in Asia
- 116 Water in agriculture
- 117 Control of Newcastle disease and duck plague in village poultry
- 118 Improving the management of irrigation schemes in Vietnam
- 119 Agriproduct supply chain management in developing countries
- 120 Spiny lobster ecology and exploitation in the South China Sea region

Technical reports

- 31 *Styrax tonkinensis*: taxonomy, ecology, silviculture and uses
- 37 Mycotoxin contamination in grains
- 45 Rodent biology and management
- 48 Genetic transformation, regeneration and analysis of transgenic peanut
- 49 *Chukrasia*: biology, cultivation and utilisation
- 52 Rice–shrimp farming in the Mekong Delta: biophysical and socioeconomic issues
- 56 Feeds and feeding for inland aquaculture in Mekong region countries
- 58 Evaluation of international provenance trials of *Casuarina equisetifolia*
- 61 Production technologies for low-chill temperate fruit

Working Papers

- 53 Priorities for pig research in Southeast Asia and the Pacific to 2010
- 54 Mud crab aquaculture in Australia and Southeast Asia
- 57 A Survey of marine trash fish and fish meal as aquaculture feed ingredients in Vietnam