Country Profile

Cambodia
Lao PDR
Thailand

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 to give a snapshot of the collaborative research being carried out between Australia and our various partner countries. This publication contains short summaries of bilateral and multilateral projects with Cambodia, Lao PDR and Thailand that were active between 1 July 2005 and 30 June 2006. At that time there were 24 active bilateral projects and three active multilateral projects (which involve partnering with an international agricultural research centre). There were another 21 bilateral projects and one multilateral project under development, many of which are expected to start in 2006–07 financial year.

This publication also sets out the key outputs and outcomes from eight bilateral projects and one multilateral project that have been completed between 1 July 2005 and 30 June 2006.

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

ACIAR updates this profile each year and distributes it to key stakeholders in Cambodia, Lao PDR, Thailand and Australia.

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

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October 2006

Cambodia Report 2005–06

(extract from ACIAR Annual Report 2005–06)

Active projects in 2005–06	13
AOP budgeted expenditure in 2005–06	$1,615,000
Actual bilateral country expenditure in 2005–06	$1,435,960
Bilateral country expenditure in 2004–05	$1,212,879
Bilateral country expenditure in 2003–04	$997,832

Key performance indicators	**Performance 2005–06**
• Opportunities explored to link with the new AusAID rural development program approach in Cambodia	Detailed design and implementation of the program have been delayed until 2006–07 and 2007–08. However, ACIAR has been closely involved in input to and review of preliminary designs
• Better linkages established between Cambodian research and extension organisations in ACIAR projects	Formal involvement of provincial extension organisations and/or extension-oriented NGOs in many R&D projects, including ASEM/2003/007 (*CARF*), ASEM/2000/109 (*farming systems diversification*), AH/2002/099 (*fasciolosis control)*, HORT/2003/045 (*vegetable production*) and SFS/2000/007 (*rodent management*).
• Outputs of Cambodian Agricultural Research Fund projects communicated in symposia and the technical literature	Outputs communicated in national and institutional symposia, in technical publications (including *Cambodian Journal of Agriculture*) and to NGOs and extension organisations.
• Improved description of land systems for diversification of crops from rice	Project LWR/2001/051 has provided and disseminated improved descriptions of land in relation to crop diversification in the provinces of Kampong Cham, Battambang and Takeo.
• Market systems for soybeans and maize characterised and improvements suggested	ASEM/2003/012 characterised market systems for soybean and maize. Suggested improvements include facilitation of credit flows (by overcoming bureaucratic obstacles to existing schemes) and setting up a special agricultural development zone.
• Program approach to assistance in horticultural R&D developed	In collaboration with the Asian Vegetable R&D Center, the Cambodian Agricultural Research and Development Institute, the Department of Agronomy and Agricultural Land Improvement and several local NGOs, the team for ACIAR project HORT/2003/045 adopted a program approach to horticultural development which utilises 'whole of supply chain' mapping, analysis, and quality improvement strategies.
• Completion of initial aquaculture feeds trials	Initial problems with project communications in Cambodia have now been addressed and progress with diet ingredient surveys and on-farm monitoring is back on schedule. An Australian Volunteer was appointed to improve communication and project monitoring.

Position

Cambodia is a relatively new partner country for ACIAR. Australia has pledged to provide significant development assistance over the medium term. ACIAR has established links through several of its projects to concluding and new AusAID-supported extension, community and market development initiatives. During 2005–06 there was a consolidation of earlier research after significant increases in the ACIAR program size over the last three years.

Cambodia has a very low per capita GDP and a predominance of rice-based farming systems on infertile soils, leading to low agricultural productivity relative to both its labour force and land-area parameters. The suite of current, pipeline and completed projects targets research to improve rice productivity, assess land suitability for a second rice crop, and develop options for production and marketing of non-rice crops. ACIAR continues to support selected initiatives in animal health and production as well as fisheries. A group of Australian-trained Cambodian researchers now have skills to help them contribute significantly to the development of Cambodian agriculture. Several other donor programs in Cambodia have an agricultural and rural development focus, and where possible ACIAR establishes linkages with these programs.

Achievements

ACIAR manages and co-funds the **Cambodian Agricultural Research Fund** (CARF), established as a component of the AusAID-funded 'Cambodian Agricultural Research and Development Institute Assistance Project'. CARF was established in 2002 to provide Cambodian scientists with an opportunity to compete for agricultural research funds. In 2005, there were 20 successful project grants. The grants are for up to three years, and cover a wide range of subjects including rice production, aquaculture, pest control, minimising after-harvest damage of mangoes, reduction of rice damage due to rats and insect pests, and banana improvement. Some of the CARF projects have linkages with larger ACIAR projects.

A major thrust of ACIAR-funded research involves **opportunities for crop diversification**. In July 2005, members of the Cambodian and Australian project team visited Vietnam. Afterwards they recommended that short-duration (90 days or less) varieties of upland crops from Vietnam should be evaluated in Cambodia as a strategy to reduce the risk of crop failure due to climate variability and drought. The trip also highlighted the need to develop integrated pest management for management of weeds, disease and insect pests in upland cropping systems in both Vietnam and Cambodia. Another decision was to investigate and promote the value of reduced/zero-tillage, mulching crop residues and growing green manure crops—to improve soil sustainability, reduce the risk of crop failure and improve the income security of the farmers.

Land suitability assessment is a way of identifying **prospective areas for crop diversification**. A project has made assessments for three districts, one in each of the provinces of Battambang, Kampong Cham and Takeo. Now a one-year extension will complete land capability classification for basaltic and sandy terrain, broaden the application of the land capability classification already developed and produce land suitability assessments. As well the researchers will broaden the use of the land resources database as a Khmer resource, and study the implications of including upland soils in the Cambodian Agronomic Soil Classification System.

The second thrust relates to sustaining rice production systems. Little is known about the distribution, **prevalence or impacts of rice diseases** such as brown spot, rice blast, false smut, bakanae and kernel smut in Cambodia. Local plant pathology expertise is very limited, thus a project is training Cambodian researchers in basic plant pathology techniques. Two Cambodian scientists have visited Charles Sturt University, Wagga Wagga for training in plant pathology principles and methods specially tailored to needs of Cambodia. They also visited the Agricultural Scientific Collection Unit at Orange to spend time at the plant pathology herbarium and see demonstrations in plant bacteriology techniques. They spent time at a new plant pathology laboratory at Wagga Agricultural Institute learning the principles of laboratory design and work flow. There followed two days for planning the laboratory setup and workflow for the CARDI plant pathology laboratory.

In Kampong Cham Province researchers investigated factors affecting the adoption of the **community trap barrier system** (TBS) to control rodents. They concluded that the adoption of the technology was limited because the effort of establishing and maintaining the community TBS is only justified if rodent damage to crops is high. However, in those areas where it was justified, the number of participating farmers, and the quality of TBS construction and maintenance did not decline over the project period, indicating that the community TBS is sustainable. In another trial a group of farmers tested zinc phosphide bait (an affordable technology for rice farmers) and found that bait uptake and palatability was improved by replacing maize with rice as the bait base. They also learnt to manufacture wax block bait, which is weather-resistant and unpalatable to non-target species such as chickens and dogs. The participating farmers improved both the TBS and zinc phosphide baiting technologies, and in workshops helped to teach other farmers.

In developing a model for the **control of fasciolosis** (tropical liver fluke infection) **in cattle and buffaloes** in rice-based farming systems, researchers made significant progress in predicting the prevalence of the disease in different regions. As well a model package was developed to ensure quality extension to farmers. Now the project has been extended to ensure that the farmers actually maintain the control methods they have been taught. A survey has been carried out to assess what methods of control are still in place 6 and 12 months after the extension has finished. The survey will also ensure that any problems such as poor access to anthelmintic medication are addressed.

Cambodia Plan 2006–07

(extract from ACIAR Annual Operational Plan 2006–07)

GNI per capita[1]	
Population[2]	14.1 million
Population 2015/2050[3]	17.1 / 26 million
Active bilateral projects	7
Active multilateral projects	0

Bilateral Actual 2004–05*	$1.19m
Bilateral Forecast 2005–06*	$1.61m
Bilateral Budget 2006–07*	$1.61m
Bilateral + Multilateral budget 2006–07	$1.61m

*Includes AusAID funding: $0.17m (actual 2004–05), $0.17m (forecast 2005–06), $0.20m (budget 2006–07).

Medium–term strategy

ACIAR's strategy in Cambodia has two thrusts: firstly to support applied research that underpins agricultural diversification, particularly into non–rice crops, and secondly to supporting research that aims to increase the productivity of rice–based farming systems. As markets develop in Cambodia, ACIAR will place greater emphasis on research to underpin the development of suitable supply chains. Maintaining and increasing rice yields remains critical to improving food security and incomes in Cambodia. Rice security and income from rice enables farmers to invest in higher value activities such as vegetables, fisheries or livestock. Increasing rice yields can reduce the area under rice cultivation, also making more farm land available for higher–value agricultural activities. The program has a strong emphasis on building Cambodian research capacity and encourages the development of collaborative linkages between Cambodian organisations.

Key performance indicators for 2006–07

- Linkages maintained and expanded between Cambodian research and extension organisations in ACIAR projects
- Cambodian Journal of Agriculture issues published with reports of successful ACIAR-funded research
- New animal health and livestock bio-security program developed and implemented
- Project activities to enhance beef production designed and commenced
- Disease management strategies for tomatoes assessed in the field
- Two Cambodian scientists trained in identification and management of rice diseases
- 40 per cent of new projects designed to have significant farmer or policymaker impacts within five years of completion

Position

Australia took a major role in assisting Cambodia on its path to democracy in the early 1990s, and in doing so pledged to provide significant development assistance over the medium term. A major component of the AusAID assistance in Cambodia continues to be in agriculture and rural development, and ACIAR will endeavour to link its research projects to new AusAID

[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.

programs. Several other donor programs in Cambodia have an agricultural and rural development focus, and where possible linkages with these programs will be established.

Cambodia has a very low per capita GDP and the predominance of rice-based farming systems on infertile soils means that Cambodia has rather low agricultural productivity on both a labour and land area basis. The suite of current, proposed and completed projects is targeted at research to improve rice productivity, assessing land suitability for a second rice crop, and developing options for the production and marketing of non-rice crops. ACIAR will continue to support selected initiatives in animal health and production as well as fisheries. Considerable progress has been made in developing the scientific expertise of a number of Australian-trained Cambodian researchers who should be able to contribute significantly to the development of Cambodian agriculture. ACIAR will also maintain an emphasis on short–course training in areas such as R&D priority–setting and management, enhancing research–extension linkages, scientific proposal and report writing in English, and in experimental design and analysis. This will also include training and technical assistance with the production of the Cambodian Journal of Agriculture.

Relationship to the AusAID Cambodia strategy

The Australia-Cambodia Development Cooperation strategy emphasises poverty reduction and sustainable development in Cambodia, through three objectives: increasing productivity and incomes of the rural poor; to reduce vulnerability of the poor; and strengthening the rule of law.

The ACIAR program through its two emphases (underpinning agricultural diversification, and supporting research that aims to increase the productivity of rice–based farming systems) directly supports the four thrusts of the first objective of AusAID's program, namely improved farming techniques, product processing, access to market information and addressing market policy constraints.

Indicative priorities

Priorities for ACIAR–Cambodia cooperation are established through meetings between ACIAR research program managers and executive staff and Cambodian agricultural R&D institutions, government departments and other organisations active in rural development in Cambodia.

New projects will be considered in the areas of field crop improvement and management, horticulture, land and water resources, animal health, and agricultural systems economics and management. Projects should fall under the following thematic programs:

Key program managers

Dr Ken Menz, Agricultural Systems Economics and Management
Dr Peter Rolfe, Animal Health
Dr Paul Fox, Crop Improvement and Management
Mr Les Baxter, Horticulture
Dr Ian Willett, Land and Water Resources

Country Manager

Ms Chiraporn Sunpakit, ACIAR Regional Manager Burma, Cambodia, Lao PDR and Thailand

Lao PDR Report 2005–06

(extract from ACIAR Annual Report 2005–06)

Active projects in 2005–06	14
AOP budgeted expenditure in 2005–06	$832,000
Actual bilateral country expenditure in 2005–06	$770,466
Bilateral country expenditure in 2004–05	$824,152
Bilateral country expenditure in 2003–04	$714,519

Key performance indicators	**Performance 2005-06**
• Through consultation with Lao PDR partners and international donors, continue to develop a new strategy for ACIAR's investment in Lao PDR for the 2005–2008 period	New strategy document developed, and thrusts endorsed by ACIAR Board and key Lao PDR stakeholders during July 2006 Board visit to Lao PDR.
• Better identification of research and extension interventions which may help to reduce the extent and impacts of shifting cultivation	Priorities for investment in agroforestry for upland communities determined and scoping study on livestock investments for these communities under way. Extension activity on scaling up of adoption of new technologies in shifting cultivation areas not yet designed.
• Scaling out of low-chill fruit production to community groups	In project CP/2001/027, *new field sites of peach, plum, nectarine and persimmon* have been established on the Plain of Jars and the Kang Pho Research Station and a fruit nursery has been established at Ponsavan. Scaling up of low-chill fruit production by community groups has commenced, particularly of nectarines which Lao consumers prefer to peaches.
• Increased recognition by local and national governments of the salinity hazards of irrigation expansion and catchment clearance	The Department of Irrigation and Suvannakhet provincial government have been briefed and now recognise the salinity hazards of expanded irrigation developments.
• Design of new forestry projects targeting improvements in smallholder timber and non-timber forest product production	A scoping study, FST/2005/180 on teak/non-timber forest products agroforestry, is complete and being used to finalise the design of a large project in Lao PDR. A second project, aimed at improving timber processing in Lao PDR, FST/2005/100 (*Value adding to Lao plantation timber products*) is at an advanced stage of development.

Position

ACIAR's program in the Lao People's Democratic Republic (Lao PDR) began in 1992, coinciding with the period of expansion of Australia's aid program to the Mekong countries. Distinguishing features of this landlocked country are low population density, high ethnic diversity, poor infrastructure, and geographical dispersion of people. Agriculture employs over 80 per cent of the population and forms 53 per cent of GDP.

A major emphasis of past ACIAR work has been the establishment in Vientiane of an animal diseases laboratory to service Lao PDR. Other successes include the introduction and selection of cold- and drought-tolerant rice varieties, identification of the major rodent pests affecting rice farming, capacity-building in forestry research and agricultural extension approaches, management of indigenous fisheries, and provision of training, including in scientific data analysis and scientific writing in English.

ACIAR recently supported a small grants scheme to enable Lao researchers to develop skills in the design and management of agricultural research projects.

Achievements

A project in Lao PDR, Cambodia and Australia studying **rice breeding strategies** for rainfed lowlands has developed a direct-seeding technology for rice that has now been tested and adapted in Lao PDR and Cambodia. Farmers are now adopting the technology, in association with short-season rice cultivars from previous work elsewhere. Direct sowing is an important variation of cropping practice that enables successful double cropping in the variably short rainfed season. Farmers have responded favourably to the introduction of simple plastic-dome technology, adapted from Japan, to protect seedlings from low temperatures in northern areas of Lao PDR and enable a second—in this case irrigated dry-season—crop in their production system. The project has developed techniques to screen germplasm for drought resistance and low-temperature tolerance, and has identified germplasm that is 3^{o}C more cold-tolerant than current Australian cultivars.

In collaboration with World Vision, another project has sought to facilitate farmer uptake of ACIAR project results relating to **improving crop yields** for farmers in rainfed rice-based systems in Savannakhet. The project has trained and mobilised district extension workers who have then formed farmer groups in 32 villages (involving 157 farmers), encouraging them to undertake on-farm variety/fertiliser trials. The trials have successfully demonstrated the yield advantage of improved varieties and improved fertiliser practice. Now the farmer groups have the knowledge to identify further improvements in crop management.

Development of a systems approach to **rodent management** in the Lao upland environment is proceeding well. Core project sites have been identified and established in Luang Namtha and Luang Prabang with the valuable assistance of World Vision. Focus group discussions in conjunction with a social mapping and wealth analysis exercise have given solid background data for each site. The researchers also conducted a survey of the knowledge, attitudes and practices (KAPs) of farmers from each site. Preliminary results show that 97 per cent of farmers considered rodents their main pest problem. Four key farmers identified in each village are assisting with collection of data and implementation of research activities. Trapping protocols were established to monitor the breeding activity of the main pests, with monthly samples collected from key habitats.

Disease is the major problem for pig farmers in Lao PDR. **Classical Swine Fever** (CSF) is endemic and many outbreaks are reported annually. A project is conducting research on the implementation and impact of CSF vaccination in the village pig production systems. Development of a simple diagnostic test is now well advanced and available as an easily read immuno-magnetic bead (IMB) ELISA. Concerns remain about the routine use of locally produced vaccine in the villages to prevent CSF outbreaks, because of the relative instability of the vaccine and the difficulty of maintaining the proper storage conditions out in the provincial centres.

In a project designed to accelerate the **impacts of participatory research and extension** on shifting cultivation farming systems, researchers tested three methods of introducing potentially useful technologies to 53 villages. They held classes using photos and system sketches and undertook cross visits to villages that had already adopted the impacts, also visits to 'champion' farmers. Interviews conducted with farmers and district staff several months after the case study trials revealed that farmers found the cross visits the most effective means of gaining an informed awareness and confidence in trialling forages. Cross visits were also the preferred learning method for most farmers interviewed, because they could see the technology in use and interact with the host farmers. They could immediately apply what they had learnt due to the practical knowledge (and in many cases planting material) they had acquired.

Lao PDR Plan 2006–07

(extract from ACIAR Annual Operational Plan 2006–07)

GNI per capita[4]	
Population[5]	5.9 million
Population 2015/2050[6]	7.3 / 11.6 million
Active bilateral projects	6
Active multilateral projects	1

Bilateral actual 2004–05	$0.80m
Bilateral forecast 2005–06	$0.83m
Bilateral budget 2006–07	$1.19m
Bilateral + Multilateral budget 2006–07	$1.33m

Medium-term strategy

ACIAR will continue to support a moderate-sized program in Lao PDR with emphasis on major technical issues addressing alternatives to shifting cultivation in the uplands through better crop and forest production and livestock health and production and on agricultural diversification to improve productivity of lowland farming systems. Where appropriate, research interventions are designed to complement other larger donor programs on improving rice production, forages, forestry and animal health.

Key performance indicators (2006–07)

- Through consultation with Lao PDR partners, a new strategy for animal health and livestock biosecurity developed and implemented
- Small grants scheme for Lao research institutions implemented and engages returned, overseas-trained Lao scientists
- Improvements in productivity of rice-based farming systems in central Lao PDR reduce seasonal food insecurity

Position

ACIAR has had a program in Lao PDR since 1992, coinciding with the period of expansion of Australia's aid program to the Mekong countries. Distinguishing features of this landlocked country are low population density, high ethnic diversity, poor infrastructure, and geographical dispersion of people. Agriculture employs over 80 per cent of the population and forms 53 per cent of GDP. A major emphasis of past ACIAR work has been the establishment in Vientiane of an animal diseases laboratory to service Lao PDR. Other successes include the introduction and selection of cold- and drought-tolerant rice varieties, identification of the major rodent pests affecting rice farming, capacity building in forestry research and agricultural extension approaches, management of indigenous fisheries, and provision of training, including in scientific data analysis and scientific writing in English. ACIAR has recently supported a small grants scheme to enable Lao researchers to develop skills in the design and management of agricultural research projects. In 2006-07, a number of new projects will commence as ACIAR expands its Lao PDR program where opportunities for research collaboration with a high likelihood of farmer impact exist.

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[4] Source: Commonwealth of Australia, *Australia's Overseas Aid Program 2006-07*, Statement by Minister Alexander Downer, May 2006.
[5] 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.
[6] 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.

Relationship to the AusAID Lao PDR strategy

The AusAID program in Lao PDR aims to assist Lao PDR to improve the pre-conditions for poverty reduction and sustainable development. It supports "appropriate recipient government development priorities as well as donor coordination and harmonisation efforts, in order to maximise development impacts…". Sectorally the country strategy focuses on building Lao human capital by improving access to education; promoting the growth of the market economy by expanding access to private land titles and strengthening property rights; and reducing the vulnerability of the poor by reducing the impact of natural disasters and unexploded ordnance.

While the ACIAR program, in focusing on agriculture and forestry, differs in its sectoral emphasis, its overall purpose (poverty reduction and sustainable development) and strategic approach is similar. There is also a strong emphasis on assisting the Lao government's own development priorities in agricultural research for development, and there is a particular effort in Lao PDR to harmonise with other donor programs through supporting underpinning research. Interventions in horticulture, livestock, forestry and agroforestry specifically target the market economy and the program has a strong emphasis on capacity development training in agricultural research and extension.

Indicative priorities

Priorities are determined through discussions, interactions and visits between scientists and research managers from Lao PDR, ACIAR and Australian institutions. Future collaborations will continue to encourage linkages with other donor-funded programs and aim to extend the impact of previous ACIAR-funded projects in the region.

It is envisaged that new projects will be considered in the areas of animal health, forestry, fisheries and crop improvement and management to sustain crop diversification and reduce impacts of shifting cultivation under the following themes:

Key program managers

Dr Ken Menz, Agricultural Systems Economics and Management
Dr Peter Rolfe, Animal Health
Dr Paul Fox, Crop Improvement and Management
Dr Russell Haines, Forestry

Country Manager

Ms Chiraporn Sunpakit, ACIAR Regional Manager Burma, Cambodia, Lao PDR and Thailand

Thailand Report 2005–06

(extract from ACIAR Annual Report 2005–06)

Active projects in 2005–06	19
AOP budgeted expenditure in 2005–06	$375,000
Actual bilateral country expenditure in 2005–06	$501,180
Bilateral country expenditure in 2004–05	$522,291
Bilateral country expenditure in 2003–04	$1,102,630

Key performance indicators	**Performance 2005–06**
• Improved implementation and measurement of results of earlier ACIAR projects	Not achieved. However, funding has now been received from the Australia-Thailand Institute to conduct a joint forum on this subject in October–November 2006.
• NGOs building on ACIAR-funded pilot projects using their own resources; & • Evidence of increased farmer involvement in projects on soil fertility management, crop production and fisheries	The main mechanism has been through World Vision and its partners continuing to invest their own resources in scaling up the pilot activities supported by ACIAR. This, together with farmers investing their own time and resources has led to increased farmer involvement. Khon Kaen University has also been active with a number of farmer groups in scaling up earlier ACIAR work on soil fertility management.
• Policy briefs on technical changes resulting from research interventions used for planning by Thai research managers	Dissemination workshops held with government research managers of the impacts on poverty of technology change, as a component for setting priorities on the basis of research impacts. Policy analysis from ACIAR-funded Sanitary and Phytosanitary project was utilised by several Thai food companies; it is important in managing standards to assist them in international arrangements for accessing overseas markets.
• Acceptance by government departments responsible for pollution control of recommendations on maximum concentrations of key heavy metals in soils and crops •	Government agency in Thailand has incorporated standards developed by the ACIAR project for maximum concentrations of key heavy metals in both soils and crops.

Position

Thailand was an early and large ACIAR collaborator, but as its own economic and research capacity has increased, its involvement in ACIAR projects has diminished. Successful outcomes include techniques to ensure longer shelf life that have enabled the expansion of tropical fruit exports, the development of cooler climate fruits for the hilly regions of northern Thailand, and fruit fly identification and control. New fish feed made from cheap, locally available ingredients has helped thousands of Thai fish farmers. A substantial investment in diagnosis and control of foot-and-mouth disease has made Thailand the accepted regional centre of expertise in Southeast Asia. The use of software developed under ACIAR support to assist in selection in cattle breeding programs has been recognised through national awards. Over 10,000 hectares of suitable fast-growing Australian trees are planted each year as a result of ACIAR-funded research.

Australian investment in projects will continue to decrease and ACIAR has adopted a highly selective approach to project investment, seeking to focus on implementation of earlier ACIAR project results. This includes research and trade policy and how it can ultimately benefit very poor farming communities. In some cases there are spillovers that bring less developed countries the benefits of research outcomes arising from development experiences in Thailand.

Achievements

Legumes are commonly used in farming systems to improve soil fertility, yet in some instances their use with inappropriate management practices has led to problems of **soil acidity and nutrient depletion**. This was the situation near Khon Kaen in Thailand where *Stylosanthes* has been introduced into pasture production systems. A project has demonstrated that heavy applications of amendments such as termite mound material and bentonite can reduce acidity and restore fertility to the area's degraded sandy soils.

Fisheries in the Mekong River Basin are under threat from development taking place in the region. Better management of fish stocks is needed, but the complexity and diversity of approximately 1700 species require management based around discrete groups. A project is using molecular genetic techniques to identify gene pools and hence discrete groups within the various species. Four member countries of the Mekong River Commission MRC (Vietnam, Cambodia, Lao PDR PDR and Thailand) have provided samples for genetic analysis at the Queensland University of Technology. As well, workshops are extending information to member countries on the conceptual basis of population genetic approaches to fish stock identification. Researchers now understand patterns of genetic variation in the Mekong basin for one of the target species (*Henichorynchus siamensis*), and analyses are now complete for all *Henichorynchus* spp. samples except those collected in Lao PDR.

During the past decade, recurrent disease outbreaks, particularly viral diseases, have caused catastrophic losses in **farmed marine shrimp** throughout the Asia-Pacific region. Many smallholders, who comprise the vast majority of shrimp farmers in Asia, have suffered significant hardship and incurred heavy debts—often leading to abandonment of the farm. Researchers involved with intensive pond production systems in Thailand and Australia (as well as semi-intensive systems in Indonesia and extensive in India) have sought to develop and validate farm-level disease control programs for smallholders. All countries have cooperated to produce a pool of best management practices from which each partner can then formulate an adaptation best suited to its own situation. Significant gains in terms of increased successes, production and profitability were recorded for groups associated with successful validation and demonstration ponds. Other significant impacts were in improved food safety and certification.

A **new disease** of *Penaeus monodon* shrimp production in Thailand, termed 'monodon slow growth syndrome' (MSGS), has led to losses in 2004 estimated around 40 million baht. Work at Centex Shrimp in Thailand has suggested that the disease is infectious. Examination of shrimp with signs of the disease has identified three infectious agents—a yellow head virus genotype, a new shrimp virus (named Laem Singh virus) and a microsporidium protozoan. Further work is under way to determine which, if any, of these agents is the primary cause of MSGS.

Earlier research to improve **hatchery and grow-out technology** for marine finfish in the Asia-Pacific region made substantial improvements to the sustainability of the region's marine finfish aquaculture. Further research has focused on improving survival of hatchery-reared high-value marine finfish larvae, and increasing the reliability of hatchery production. The Thai-based *Asia-Pacific Marine Finfish Aquaculture Network* has been strengthened and it is now undertaking or coordinating a broad range of research, extension and communication activities.

Thailand is one of five countries—the others are Australia, Malaysia, Philippines and Vietnam—involved in a project to **conserve the genetic resources of selected tropical fruits** and related species by developing new conservation methods and regeneration strategies. IPGRI is the regional project coordinator. Scientists in each country have focused on two or three species of major economic importance (examples are *Citrus* species, litchi, longan, mango, papaya and persimmon) and also studied the wild relatives of these species. Significant advances were made for papaya, citrus and mango but, given the number of species involved across five countries, making substantial gains will only occur in the long term.

Scientists studied watersheds at Mae Chaem (northern Thailand) and Sumber Jaya (Lampung, Indonesia) to determine how current **trends in land-use are affecting water quantity and sediment load in rivers**, then using this data to project future trends. They use participatory resource mapping and dynamic modelling at *plot* scale to establish water and sediment flows. Then they test soil and water movement in landscape mosaics at *catchment* scale, establishing trade-off between watershed functions and profitability of land use for current and future purposes. They have undertaken the work using the 'catchment modelling toolkit' developed within the Cooperative Research Centre for Catchment Hydrology. In the Mae Chaem catchment a study of riparian (riverbank) vegetation has given scientists the ability to delineate the 'hot spot' areas of sediment delivery.

Thailand Plan 2006–07

(extract from ACIAR Annual Operational Plan 2006–07)

GNI per capita[7]	
Population[8]	64.2 million
Population 2015/2050[9]	69.1 / 74.6 million
Active bilateral projects	7
Active multilateral projects	2

Bilateral actual 2004–05	$0.51m
Bilateral forecast 2005–06	$0.38m
Bilateral budget 2006-07	$0.21m
Bilateral + Multilateral budget 2006–07	$0.27m

Medium–term Strategy

ACIAR's small Thailand program seeks greater implementation of the results of earlier projects (often in conjunction with NGOs) and also has a focus on research and trade policy and how it can ultimately benefit very poor farming communities. In keeping with the graduation of Thailand as a recipient of aid to one of emerging donor, only a very limited number of new and small cofunded activities, all of which will focus on implementation of the results of earlier ACIAR projects, will be considered in future. Opportunities for partnering with Thailand on activities in the region will also be explored.

Key performance indicators (2006-07)

- All new projects under development are focusing on implementation of results of earlier ACIAR projects
- NGOs and farmer groups continuing to build upon ACIAR–funded pilot projects using their own resources
- Policy briefs on food safety regulation used for planning by Thai government or industry

Position

Thailand was an early and large collaborator with many projects successfully undertaken. However, as Thailand's own economic and research capacity has increased, its involvement in ACIAR projects has diminished. Successful outcomes include techniques to ensure longer shelf life that have enabled the expansion of tropical fruit exports, the development of cooler climate fruits for the hilly regions of northern Thailand, and fruit fly identification and control. New fish feed made from cheap, locally available ingredients has helped thousands of Thai fish farmers. A substantial investment in diagnosis and control of foot–and–mouth disease has made Thailand the accepted regional centre of expertise in Southeast Asia. The use of software (developed under ACIAR support) to assist in selection in cattle breeding programs has been recognised through national awards. Over 10,000 hectares of suitable fast–growing Australian trees are planted each year as a result of ACIAR research.

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[7] Source: Commonwealth of Australia, *Australia's Overseas Aid Program 2006-07*, Statement by Minister Alexander Downer, May 2006.
[8] 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.
[9] 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.

It is expected that Australian investment in projects will continue to decrease in line with the increasing ability of Thai partners to co–invest in projects of strong mutual importance. In some cases, there are spillovers to less developed countries from drawing on the development experiences of Thailand. ACIAR's project investment will be very highly selective and will focus only on implementation of the results of earlier ACIAR projects.

Indicative priorities

ACIAR held its most recent consultation to establish priorities for research collaboration with Thailand in November 2000. The full record of the consultation is at www.aciar.gov.au under Partner country priorities/Thailand. At that consultation the themes of application of biotechnology, product quality and quality control, natural resources management, and information dissemination and technology transfer were given priority, and the current portfolio of projects that are being completed or have recently concluded largely reflects this emphasis.

Overarching issues include the potential benefits from technical and policy research to underpin trade of agricultural products, and the importance of policy research and market chain incentives in underpinning agricultural developments. Opportunities to promote the application of technology, using both conventional extension methodologies and new approaches were noted, especially for the benefit of farmers in upland northern Thailand and Northeast Thailand.

Key program manager

Dr Ray Trewin, Agricultural Development Policy

Country Manager

Ms Chiraporn Sunpakit, ACIAR Regional Manager Cambodia, Lao PDR, Thailand and Burma

Active projects

at 30 June 2006

Bilateral

Bilateral

ADP/2000/004: International food safety regulation and processed food exports from developing countries: A comparative study of India and Thailand

Overseas Collaborating Countries	India, Thailand
Commissioned Organisation	Australian National University, Australia
Project Leader	Professor Prema-Chandra Athukorala Phone: 02 6125 8259 Fax: 02 6125 3700 Email: prema-chandra.athukorala@anu.edu.au
Project Web Site	http://rspas.anu.edu.au/economics/aciar/
Collaborating Institutions	Research Information Systems for the Non-aligned and Other Developing Countries, India University of Melbourne, Australia International Food Policy Research Institute, USA Thammasat University, Thailand
Project Budget	$621,895
Project Duration	01/01/2002 to 30/06/2007 (Project extended from 01/01/2006 to 30/06/2007)
ACIAR Research Program Manager	Dr Ray Trewin

Project background and objectives

India and Thailand, like a number of other agricultural resource rich developing nations, have experienced significant expansion of processed food exports. In recent years Thailand has exported over US$10 billion worth of processed food (4 per cent of GDP) and India over US$3 billion worth (2 per cent of GDP). However, both India and Thailand, and other developing countries, have experienced significant problems in exporting processed food to lucrative markets in developed countries. These trade conflicts often relate to food safety standards and their inability to meet the WTO Sanitary and Phytosanitary (SPS) Agreement. For example in 1999–2000 there were 860 shipments of fishery, vegetables and fruit products from India placed in detention in the US and 684 cases of products from Thailand.

SPS issues have become a significant source of international trade friction and dispute. While the development of food processing export industries offers enormous potential for rural development and economic growth in developing countries, problems with meeting these standards are considered a major constraint to achieving this growth. There is a lack of adequate information on the problems that constrain firms' abilities to meet international standards.

This study aims to examine the policy, institutional and technical problems faced by processed food exporters in developing countries in meeting SPS requirements, and to identify appropriate policy measures minimise their negative impacts on exports and enhance their capacity to meet SPS standards while recognising the legitimate concerns in importing countries about safety and quality.

Project progress

This year's report is awaited as at October 2006; the latest report has been provided for information.

Year 3 (01/01/2004–31/12/2004) report

Implementation of the project commenced on 1 April 2002. Despite the delayed start, the proposed work program for the three-year implementation period has been successfully completed. The main tasks accomplished so far included:

(a) the literature survey;
(b) analysis of trends and patterns of process food exports from developing countries and the WTO mechanism for monitoring food safety standards;
(c) and the institutional mechanisms and procedures for meeting food safety standards in India and Thailand;
(d) case studies of the selected food industries and firm-level surveys in the two countries; (e) preliminary drafts of the country reports.

The main focus of the Indian and Thai research teams during the period under review (April 2003–March 2004) was on analysing data gathered from the firm-level survey and drafting the country reports. The team leader and the main co-researcher of each team visited ANU during the year to discuss the preliminary draft of the report with the Australian team and the complete draft is to be submitted by the first week of June 2005. The Indian team has surveyed 71 firms. These include firms in the following industries: shrimp (57) mango pulp (7), egg powder (3) and mushroom (4) industries in the states of Kerala, Tamilnadu, Andra Pradesh, Chandigar and Maharashtra. The Thai team has surveyed 55 firms—shrimp (40), canned tuna (8) and vegetable (7). (Note that our aim was to survey a minimum of 50 firms in each country.)

The Australian team was involved in writing/finalising the background chapter for the synthesis volume, which contains three main sections:

(1) international food safety regulation and process food exports from developing countries,
(2) causes and incidence of detention of processed food imports (based on data compiled from administrative records of the US Food and Drugs Administration), and
(3) economics of food safety regulation and trade.

The project leader (Athukorala) and the leader of the Melbourne University team (Jayasuriya) made field visits to Thailand (one week) and India (two weeks) in September 2004 to monitor fieldwork and data processing.

ADP/2002/012: Technical change in Thai and Indonesian agriculture: measurement, socio-economic impact and policy implications

Overseas Collaborating Countries	Indonesia, Thailand
Commissioned Organisation	Australian National University, Research School of Pacific and Asian Studies, Australia
Project Leader	Professor Peter Warr Phone: 02 6125 2682 Fax: 02 6125 3700 Email: peter.warr@anu.edu.au
Collaborating Institutions	National Center for Genetic Engineering and Biotechnology, Thailand Chulalongkorn University, Thailand Bogor Agricultural University, Indonesia Centre for Agriculture Socio-Economic and Policy Studies, Indonesia
Project Budget	$399,799
Project Duration	01/01/2004 to 31/12/2007 (Project extended from 01/01/2007 to 31/12/2007)
ACIAR Research Program Manager	Dr Ray Trewin

Project background and objectives

Productivity growth in the Thai and Indonesian agricultural sectors is an important driver of poverty alleviation. In Thailand more than 90 per cent of poor people reside in rural areas; in Indonesia this figure is more than 80 per cent. In both countries the majority of these poor people are engaged in agricultural production. Raising productivity levels in both cases would help reduce poverty.

Growth in productivity in Thailand's agricultural sector has been significant, but the source of this growth is uncertain. Technical changes to improve agricultural productivity, such as improved crop varieties and management practices have been undertaken but the extent to which these have contributed to overall growth is not clear. Indonesia's experience has been different, with more rapid growth than Thailand until the early 1990s, followed by a decade of stagnating growth rates. Information about what types of technical change are most likely to reduce poverty is limited.

The role of public investment and extension services in productivity growth is also unclear. Since the economic crisis of 1997–98, both the Thai and Indonesian economies have experienced lower overall growth, and rising public debt. This has placed pressure on the role of public investment, including in the use of investment in agricultural technology and its interactions with the broader economy and impacts on poverty alleviation. Answering these questions will help create an improved understanding of the role of technical change in agricultural productivity.

The objectives of the project are:

- statistical analysis, identifying rates and factor biases of technical change in Thai and Indonesian agriculture.
- dissemination of the results of the above through workshops and publications.
- general equilibrium analysis of the social and economic effects of technical change in Thai and Indonesian agriculture.
- dissemination of the results of the above through workshops and publications.
- development of capacity for general equilibrium analysis of technical change issues in Thai and Indonesian agriculture through training and hands-on experience.

Research: To analyse the effects that technological change in Thai and Indonesian agriculture has had on key economic variables which are important for public policy, including:

- poverty incidence
- economic inequality
- export performance
- public finance
- rural–urban migration
- the economic structure of the agricultural sectors of Thailand and Indonesia.

Capacity building: To develop the capability within BIOTEC, Chulalongkorn University, Institut Pertanian Bogor (IPB) and Center for Agro Social Economic Research and Development (CASERD) to sustain research of this kind after the project is successfully completed.

Project progress

Year 2 (01/01/2005–31/12/2005)

During 2005 substantial progress was made towards the achievement of the project's core objectives. The work completed mainly represents the building blocks on which the main analytical work of the project will rest.

Econometric analysis of agricultural input and output data to determine rates and factor biases of technical change.

Thailand: Work proceeded on the assembly of data for the above exercise and the review of feasible methodologies to be used in the analysis of these data. The data are derived from the Office of Agricultural Economics of the Ministry of Agriculture and Cooperatives and are available in two parts—before and after 1989. Before 1989 data are available on both inputs and outputs, expressed in both quantity and value terms. Since 1989, data are available only in another format specified in total cost terms, and some years are missing. The econometric analysis of these data has begun, but some missing data are still being sought.

Two new data sets have now been located. The first originated with the Thailand Development Research Institute, with data available from 1961 to 1999. It is being explored for its suitability for the purposes of this project, but a major problem with this data set is that inputs such as land and labour are available only in total and not allocated across individual commodities. The second data set was assembled by researchers (Mundlak, Larson and Butzer) working at the World Bank, but it contains only aggregate data relating to the whole of the agricultural sector. An advantage of this data set is that it has data for both Thailand and Indonesia, in a comparable format.

Work has now begun with both of these data sets, specifying an aggregate production function for the Thai agricultural sector, rather than individual commodities, and analysing technical change at this level. This work is considered preliminary to the analysis of the main data set, which is needed at the level of individual commodities. However, the data problems mentioned above are problematic for this disaggregated work.

General equilibrium modelling of the effects of technical change.

Thailand: The data base of the PARA general equilibrium model has been updated to the year 2000 and the construction of a balanced data base is almost complete. This exercise has been a major undertaking. Structural changes have also been introduced to make the model more useful for the purposes of this project, especially the incorporation of multiple households for the purpose of poverty and inequality measurement. The model is now ready to be used for simulation purposes. Substantial work has been done on training the project staff from BIOTEC in the use of general equilibrium modelling software in the context of this particular model.

AH/2002/099: Development of a model for the control of fasciolosis in cattle and buffaloes in the Kingdom of Cambodia

Overseas Collaborating Countries	Cambodia
Commissioned Organisation	James Cook University, School of Biomedical Sciences, Australia
Project Leader	Dr Lee Skerratt Phone: 07 4781 4838, Mob: 0423 693 689 Fax: 07 4779 1526 Email: Lee.Skerratt@jcu.edu.au
Collaborating Institutions	Department of Animal Health and Production, Cambodia Cambodia Agricultural Research and Development Institute, Cambodia Agricultural Extension Department, Cambodia Office of Animal Health and Production, Cambodia
Project Budget	$191,406
Project Duration	01/01/2004 to 31/05/2007 (Project extended from 01/07/2006 to 31/05/2007)
ACIAR Research Program Manager	Dr Peter Rolfe

Project background and objectives

Control of fasciolosis (liver fluke) is a high priority in Cambodia. A previous ACIAR project (AS1/1996/160) gathered data on the spread of fasciolosis to produce a risk map, but much of this was out of date. The lack of accurate data also precluded the model from playing a major role in developing a national control strategy. Recent data collection by several national and regional agencies will allow the model to be updated. The project aims to update, refine and validate the risk model using geographic information systems. Extension officers will be trained with the aim of developing an extension program to control fasciolosis, leading to the development and promotion of a national strategy.

Project progress

Year 2 (01/01/2005–31/12/2005)

Fasciolosis impacts, cost benefits of fasciolosis control and its measure the acceptance on control
Cattle of different age groups in two project sites were selected for the study on the impact of the prevalence of fasciolosis on weight gain, condition score, skin status, draft ability, animal sale, and reproductive performance. This information was collected every three months from September 2004 (first time) until June 2006 (seventh time). The two project sites have similar farming systems and grazing management. Project site I is Preak Thei of Saang district, Kandal province and was used as the control group. Project site II is Preak Kseav and Preak Trang of Saang district Kandal province and was used as the non control group or treatment group.

- Control group—Project site I (Preak Thei): Extension activity was not conducted. The selected animals were vaccinated against HS, FMD and given anthelmintic for helminths other than for fasciolosis.
- Non-control group—Project site II (Preak Kseav and Preak Trang): Extension activity was conducted and Triclabendasole (the drug effective against fasciolosis) was given in addition to the same treatments that were given to the control group.

Prevalence of fasciolosis
A total of 1483 faecal samples from control and non-control groups were examined. In the control group, the infection rate of fasciolosis at the start (September 2004) was 39.35% (61 positive samples out of 155 faecal samples examined), 40.25% in January 2005, 41.66% in April 2005, 42.85% in August 2005, 44.44% in November 2005, 46.42% in February 2006 and 45.45% in June 2006.

In the non-control group, the infection rate of fasciolosis at the start was 43.42%, and then it dropped and remained low after treatment and extension activity at 1.80, 5.19, 3.77, 4.34, 4.08 and 3.12 per cent in January, April, August and November 2005 and February and June 2006, respectively.

Weight
Comparison of animal weight gain among control and non control groups found that the group receiving fasciolosis control gained 30 kg more weight per annum.

Reproductive performance
Comparison of birth rates among control and non-control groups found that the group receiving fasciolosis control had 10% more births per annum.

Animal sale
In the control group, 70.96% (110 head) of the 155 selected animals were sold, while in the non control group, 68.0% (238 head) out of the 350 animals were sold by June 2006.

Extension program to control fasciolosis in cattle in Saang and evaluation of the acceptance of the control program
Extension activities were implemented by the extension team from DAHP, OAHP of Kandal province under the supervision of extension specialists from CARDI and AED/CAAEP. A total of 587 farmers and stakeholders in project site II were involved in the education and extension training; of these 186 people attended in module I, 221 people in module II and 180 people in module III.

Evaluation of farmer/owner of understanding on fasciolosis
The farmers in the project sites were selected, interviewed and given questionnaires to evaluate their understanding on fasciolosis. Results of the follow up surveys after extension activity indicated that in project site I the average knowledge and understanding was very low, while in project site II, 21.7% responded correctly to the survey questionnaire, 51.6% responded incorrectly and 26.4% admitted they do not know about fasciolosis, its impacts and how to control the disease.

Results of a second follow up survey after more extension activity indicated farmers' knowledge and understanding between project site I and II differed greatly. It indicated that 74.8% farmers in project site II responded correctly, while the knowledge and understanding on fasciolosis and its control measures remained very low among farmers in project site I. Farmers were also interviewed to evaluate the acceptance, costs and benefits of control of fasciolosis in Saang district of Kandal province. Results from the interview indicated the following:

- Farmers were satisfied with the extension program on fasciolosis. It explained, demonstrated and helped farmers to understand the disease. In addition, it enabled them to address and discuss fasciolosis in groups.
- Farmers were convinced of the economic impacts of fasciolosis as they became involved in the program, due to the fact that infected cattle had slower weight gain, lower fertility among reproductive females, weaker draft ability, worse skin and condition scores and increased liver damage.
- Extension materials such as sign boards, leaflets and banners drew farmers' attention to fasciolosis and the control program.
- Farmers suggested that the program should be extended.

Refinement and validation of a GIS-based risk model for fasciolosis for Cambodia
The levels of prevalence of fasciolosis found in the field survey were generally in accord with predictions from the risk model, except in Stoeung Trang where the prevalence was higher than predicted. This mismatch between the GIS model and field survey results may be due to the distribution of animals and their use of the land within districts, which is unlikely to be uniform (some animals may be grazed in the areas where the risk of fasciolosis is higher), as is implied by the model. However, the general agreement of the risk model with predicted prevalence in most districts surveyed suggests that the epidemiological determinants and weightings used to produce the model are appropriate.

AH/2003/001: Management of CSF and FMD at the village level in Lao PDR

Overseas Collaborating Countries	Lao PDR
Commissioned Organisation	CSIRO Livestock Industries, Diagnosis, Surveillance and Response Group, Australia
Project Leader	Dr Axel Colling Phone: 03 5227 5255 Fax: 03 5227 5555 Email: axel.colling@csiro.au
Collaborating Institutions	University of Melbourne, Faculty of Veterinary Science, Australia International Center for Tropical Agriculture, Department of Livestock and Fisheries, Lao PDR Department of Livestock and Fisheries, National Animal Health Centre, Lao PDR
Project Budget	$399,330
Project Duration	01/07/2003 to 31/12/2006 (Project extended from 01/07/2006 to 31/12/2006)
ACIAR Research Program Manager	Dr Peter Rolfe

Project background and objectives

Smallholder farmers in Lao PDR view livestock production as a means to generating cash income. With more than 85 per cent of the country's population located in rural areas sales of livestock are vital to poverty alleviation. Almost all livestock is raised by smallholders, with pigs the most common in smallholder and village systems. Livestock production and accessing cash from sales are a 'stepping stone' away from poverty, but are limited by the persistent outbreaks of some diseases. Losses due to disease are a major constraint particularly in pig and poultry systems. Earlier ACIAR-supported research identified Classical Swine Fever (CSF) as the major cause of death in village and smallholder pig systems. Anecdotal evidence supports this finding, suggesting epidemics occurring in some regions on a two to three year cycle. Foot-and-mouth disease (FMD) is another common disease, though is not endemic in some parts of the country like CSF.

Control of both diseases is a national priority, but is limited by significant knowledge gaps for each. For FMD this centres on disease surveillance activities, which will also deliver benefits in improving skills and methodology for managing other diseases. For CSF a live virus does exist, but maintaining its efficacy has been difficult. A more stable vaccine, improved vaccine management and simple diagnostic tests are needed to rebuild farmer confidence in the effectiveness of vaccinations.

The project aims to improve the control of CSF and FMD in village pigs through:

- development, evaluation and implementation of a simple, rapid diagnostic test for CSF;
- establishment and validation of a system to apply locally produced CSF vaccine;
- evaluation of the impact of the CSF vaccine program in the village pig production system;
- monitoring the epidemiology of FMD and CSF;
- communication of project findings to extension staff and animal health and production scientists in national, regional and international networks.

Project progress

This years' annual report is forthcoming as at October 2006, last year's report has been provided for information.

Year 2 (01/07/2004–30/06/2005) report

Development, evaluation and implementation of a simple, rapid diagnostic test for CSF.
The test development has progressed well and Mr Conlan has prepared his data for submission for a MSc degree at Melbourne University. The test format was modified to a read-out using ELISA-generated colour development termed an immuno-magnetic bead (IMB) ELISA. The binding conditions of the reagents and the conditions for the performance of the IMB test have been standardised. Limited validation using the diagnostic ELISA used for antigen detection as the gold standard has established the proof of principle of the IMB test format. Mr Conlan has undertaken operator variability studies with the project staff at the National Animal Health Centre that show the IMB ELISA can be successfully transferred to the central laboratory environment in Lao PDR.

Establishment & validation of a system to apply locally produced CSF vaccine in Lao villages.
In the previous period there was concern about commencing the vaccination program in the villages until the reliability of the vaccine was established. The established antibody detection ELISA indicated that in many vaccinated pigs there was no humoral antibody response. Some of Mr Conlan's activity was redirected to evaluate the vaccine using the virus neutralisation test, revealing that the vaccine was stimulating an antibody response in some pigs. A decision was made to boost the initial vaccination in villagers with a second vaccine a month later.

The current recommended temperature for the storage of CSF vaccine produced at the National Vaccine Production Plant is -20^{o}C. A trial was carried out to compare the potency of the vaccine (as measure by antibody response) after longitudinal storage of the vaccine at 4^{o}C and at -20^{o}C. This assessment indicated that the vaccine is not stable at 4^{o}C, but maintains potency for up to 4 months at -20^{o}C as specified by the manufacturer.

The local project leader arranged the vaccination program for an extra eight villages in Borikhamxay province and in villages in two districts in Xiengkhouang province.

Evaluation of the impact of the CSF vaccine program in the village pig production system.
As indicated above this program was delayed because of the constraints on the evaluation of the vaccine. Sera have been collected from a sample of pigs vaccinated in the village program but the testing is not yet complete. Production data have been collected from the project villages during the vaccination trial.

The project is evaluating villagers' attitudes to the impact of the vaccination program as implemented by the project, as part of an attempt to influence policy about CSF vaccine production. At present it is likely that the routine use of locally produced vaccine in the villages will not prevent disease outbreaks because of the relative instability of the vaccine and the difficulty of maintaining the proper storage conditions out in the provincial centres.

Monitoring the epidemiology of FMD and CSF in Lao PDR.
The project team from the Animal Health Centre and the provincial livestock and fisheries office have continued to collect the monthly production data from the villages enrolled in the project. There have been no outbreaks of CSF reported from the project villages. The project has been collaborating with the SEAFMD campaign by undertaking FMD serological surveys in three provinces. Limited results indicate that FMD is not endemic in Savannakhet, Xiengkhouang and Houaphan. There was one type O outbreak reported in the year, and a follow-up investigation will be undertaken by the project to determine the origin.

Communication of project findings to extension staff and animal health and production scientists in national, regional and international networks.
The project has communicated the findings of the FMD studies and activities undertaken project to the Annual meeting of the SEAFMD program.

AH/2006/078: Assessing and controlling the risks of disease spread in Mekong countries with an initial focus on Cambodia

Overseas Collaborating Countries	Cambodia
Commissioned Organisation	AusVet Animal Health Services, Australia
Project Leader	Dr Angus Cameron Phone: (+33) 3 8572 7731 Fax: (+33) 3 8572 5669 Email: angus@ausvet.com.au
Collaborating Institutions	
Project Budget	$88,373
Project Duration	21/08/2006 to 01/12/2006
ACIAR Research Program Manager	Dr Peter Rolfe

Project background and objectives

In the Mekong countries there is a need to identify the drivers that spread animal disease, primarily through livestock movement, both between and within countries. In this small research activity involving a workshop and an in-country visit the scientists will develop a deeper and broader understanding of the issues relating to national and regional livestock movements in Mekong countries and their impact on the spread of livestock disease. An exchange of information and experience between the research partners will enable them to address disease control issues in a more effective and coordinated way. The report from this activity may be used by ACIAR as a springboard for further research projects in the area.

Project progress

First progress report due in 2007.

ASEM/2000/109: Farming systems research for crop diversification in Cambodia and Australia

Overseas Collaborating Countries	Cambodia
Commissioned Organisation	NSW Department of Primary Industries, Australia
Project Leader	Dr Bob Martin Phone: 6763 1258 Fax: 02 6763 1222 Email: bob.martin@agric.nsw.gov.au
Collaborating Institutions	Cambodia Agricultural Research and Development Institute, Cambodia
Project Budget	$887,589
Project Duration	01/07/2003 to 30/06/2007
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Rice is the staple crop in Cambodia, with little else grown. More than 90 per cent of agricultural cropping land is sown to rice. Crop diversification is minimal, even in upland agro-ecological systems that do not suit rice. Government policy is designed to encourage diversification with CARDI taking a lead in placing emphasis on diversified cropping. There are, however, still substantial barriers to diversification. The main barrier is a lack of familiarity with upland crops. This includes extension workers and researchers as well as farmers, whose knowledge of non-rice crops is limited, creating a perception of higher risk for planting non-rice crops. A wet monsoonal season does not guarantee predictable rainfall, this unpredictability adding to the perception of risk. As a result market infrastructure for non-rice crops is lacking.

Crop diversification is also an issue at the centre of a policy push from NSW Agriculture, who want to hasten change from cereal crops production in parts of the state. The adoption of more sustainable tillage practices is a central theme of this push.

The overall objective is to help reduce poverty and contribute to food security at household and national levels through the development of techniques and opportunities for the production of non-rice upland crops in Cambodia. In Australia the focus is on overcoming the constraints to crop diversification and adoption of sustainable practice in broadacre cropping enterprises in the subtropical slopes and plains agro-ecological region of northern Australia.

Project progress

Year 3 (01/07/2005–30/06/2006)

ASEM/2000/109 enjoys a very productive relationship between Cambodian and Australian team members. The teams possess a close sense of collaboration while maintaining a professional approach to their activities. Such an atmosphere bodes well for the final outputs and potential for making an impact on both Australian and Cambodian farming systems.

A series of workshops conducted early in the project period resulted in identification of the constraints to the adoption of diversified farming systems in both Australia and Cambodia. Australian farmers took this opportunity to discuss their constraints within a wider audience, culminating in a national conference cosponsored by GDRC, UNE and the Namoi CMA. Some farmers also formed working groups to further evaluate the potential for change through discussion between adopters and non-adopters of zero tillage technologies. Crop check software was developed to assist farmers to calculate crop management options.

In Cambodia, the results of the farmer meetings and workshops helped design a program of field research. These trials were mostly installed in farmers' fields with the assistance of farmers, provincial agricultural technicians and extensionists plus researchers from CARDI. A total of 153 on-farm experiments and demonstrations were conducted between 2004 and 2006 and included experiments on variety evaluation (43), insect pests and diseases (19), reduced tillage (22), agronomy and farming systems (69). In addition, simple diagnostic and analysis tools were drafted in the form of guides to weed and insect pests of upland crops. *Rhizobium* inoculation techniques and rapid soil nitrate tests were demonstrated for use. A crop check type system is under development for Cambodia which is adapted to target crops and socio-economic needs.

Technical information generated from the research conducted in Cambodia resulted in 'best bet' technologies being developed for the upland cropping systems. Draft field crop manuals for soybean, maize, mungbean, peanut, cowpea and sesame were prepared in collaboration with extension staff; a DSSAT crop simulation model being used to predict nitrogen fertility and other factors affecting crops. A 60-page book of gross margin analysis and general information for these six crops is also drafted.

Potential impacts of the research on upland crops in Cambodia are huge, considering that yield increases are likely and ASEM/2000/109 is the largest of a small number of projects working on upland crop issues in the country. It is too early to evaluate the extent to which the drafted technologies have influenced practices to date, but farmers at field days during the review period displayed considerable interest in the trials and individual farmers had tried parts of the technology 'packages' on their own farms. Measurements may be possible at the end of Year 4 to evaluate some economic benefits of the project.

Adoption of the project-recommended zero-till practices carries with it significant environmental advantages for Cambodia as will rhizobium inoculation of legumes and the use of IPM practices. These technologies require some refinement and possible establishment of inoculation supply chains plus training.

ASEM/2003/007: CARF—Cambodian Agricultural Research Fund

Overseas Collaborating Countries	Cambodia
Commissioned Organisation	Consultant, Australia
Project Leader	Dr John Schiller Phone: 07 3365 2987 Fax: 07 3365 1188 Email: j.schiller@uq.edu.au
Collaborating Institutions	Cambodian Agricultural Research and Development Institute Department of Animal Health and Production Department of Agronomy and Agricultural Land Improvement Royal University of Agriculture Prek Leap National School of Agriculture Kapong Cham National School of Agriculture Various NGOs
Project Budget	$1,338,743
Project Duration	01/03/2002 to 30/06/2008 (Project extended from 01/07/2006 to 31/12/2010)
ACIAR Research Program Manager	Dr John Skerritt

Project background and objectives

ACIAR manages the Cambodian Agricultural Research Fund (CARF). CARF was established in 2002 to provide Cambodian scientists with an opportunity to compete for agricultural research funds. It is open to government, university or college and NGO organisations based in Cambodia, which have the clear ability and mandate to implement research within Cambodia. CARF was a component of the AusAID-funded 'Cambodian Agricultural Research and Development Institute Assistance Project' until August 2006.

The aim of the Fund is to provide an environment of competitive tender for agricultural research. Seed funding and initial management of the fund will be provided by the Australian Government. In the medium term, it is expected that the CARF will be institutionalised within Cambodia.

Project progress

Year 4 (01/07/2005–30/06/2006)

The project was reviewed in May 2006. The review stated “CARF has delivered a comprehensive training program including the writing of research proposals, problem definition and biometry followed by individual support and coaching for over 100 scientists. CARF has operated with relatively low transaction costs, despite the intensive in-country support provided. The overall administration of the Trust Fund has been of a high order. Project documentation has been voluminous and meticulous, and liaison arrangements with Cambodian institutions and scientists have attracted much favourable comment from those institutions. Projects are required to provide six-monthly progress reports and a final report. Only one project has failed to meet these requirements, due to the impacts of avian influenza on collaborating villages.

Most CARF proponents have made serious and commendable efforts to engage with communities, to articulate their proposals with the highest priority needs of farmers and their farming systems. The CARF approach appears to have enjoyed particular success in helping to build research experience and skills in institutions new to research, including several NGO projects. The CARF grants have also helped to build partnerships between scientists and institutions and have shown an important potential to catalyse interest and co-contributions from other donors. Importantly, the competitive nature and small size of the CARF grants provide opportunities for new players to demonstrate their capacity in research, and to identify research talent that may be obscured in a larger project. The importance of CARF in providing a mechanism for institutions and young research staff to access operational funds was stressed by all Cambodian participants.

The overwhelming impression of CARF is the high level of acceptance generated within the institutions of a competitive funding system for research, and the willingness of Cambodian counterparts to meet the stringent standards, comply with external guidelines, accept the scientific criticisms to which this process has exposed them and to manage the requisite reporting, financial and acquittal processes. This new (for Cambodia) experience has clearly resulted in marked improvements in the competence and confidence of researchers of all ages and levels of experience in translating their ideas and hypotheses into fundable experiments/projects.

Overall, CARF has demonstrated very clearly the benefits that can be generated through the leverage of a well-managed small grants scheme through quite small amounts of funding. However, most CARF projects will have very great difficulty in maintaining their momentum without ongoing external (donor) support. Even within CARDI, funding for research is quite limited at the margin, and the smaller institutions and NGOs are particularly disadvantaged in this respect. CARF has been attempting to build Cambodian capacity in the formulation of research programs through its training program and general mentoring of applicants. However this remains an area of general weakness, along with experimental design, statistics, basic agricultural economic analysis and marketing.

ASEM/2003/012: Improving the marketing system for maize and soybeans in Cambodia

Overseas Collaborating Countries	Cambodia
Commissioned Organisation	University of Canberra, Australian Institute for Sustainable Communities, Australia
Project Leader	Professor John Spriggs Phone: 02 6201 2317 Fax: 02 6201 2263 Email: john.spriggs@canberra.edu.au
Collaborating Institutions	Ministry of Commerce, Cambodia Cambodia Agricultural Research and Development Institute
Project Budget	$399,950
Project Duration	01/07/2004 to 31/12/2006
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Agriculture in Cambodia has been dominated by rice, much of it grown by smallholder subsistence farmers. The Royal Government of Cambodia has set poverty reduction and improved rural development as top priorities. To achieve this Government is focusing on the development of commercial, export-oriented agriculture. Diversification in cropping from rice is one component of this work. Among non-rice crops, maize and soybean are particularly important (both have, after rubber, the highest export potential, but marketing arrangements for the two crops are largely informal and poorly developed). Constraints include postharvest inefficiency, inadequate information flows, high transport costs and lack of external market linkages, with Thailand and Vietnam representing the main external markets. For export potential to be realised these constraints need to be overcome.

ACIAR is supporting complementary research both to improve maize and soy production and help in crop diversification. Strengthening and developing marketing systems is needed to ensure the increased productivity delivers the benefits of exporting to nearby markets. Mapping of the marketing system, including supply chains and the institutional environment will substantially aid in identifying areas for development and focus by key stakeholders as they address constraints to the system's development.

The project aims to improve the well-being of participants of the maize and soybean marketing systems, with particular attention being given to the well-being of rural families and rural development by:

- mapping the existing (formal and informal) marketing systems for maize and soybeans and the institutional environment (governmental and infrastructural), to identify the constraints and capacities for change and to evaluate the potential for improvement
- facilitating a process of change within these marketing systems
- enhancing the capacity of relevant people and institutions in Cambodia

Project progress

Year 2 (01/07/2005–30/06/2006)

This is the second year of an ***action research*** project which aims to bring about positive socio-economic change in the Cambodian maize and soybean marketing systems. In the first year of the project, the focus was on the soybean marketing system of ***eastern*** Cambodia, while during the second year, the focus of the project has started to shift to ***western*** Cambodia.

We decided to treat the eastern and western marketing systems separately because the situations in the two parts of the country are very different. Two obvious differences are: (1) the relative importance of soybeans in the east and maize in the west; and (2) the relative importance of Vietnam as a market for the east and Thailand as a market for the west. However, a more fundamental (and perhaps less obvious) difference is that the marketing system in western Cambodia is dynamic while that in eastern Cambodia is not. (A good illustration of the dynamism in western Cambodia is the construction in recent years of four modern large-scale commercial silos, with a fifth on the way.) Because the situation is so different in the two regions, the nature of the appropriate research and action interventions is also different.

During the second year of this ***action research*** project, we moved from a ***research*** phase to an ***action*** phase in eastern Cambodia. This involved two initiatives:

1. a macro initiative—writing a concept paper on the idea for an **agricultural market development zone** for eastern Cambodia and presenting this to a panel of government policy decision-makers (June 2006). The panel gave a strong endorsement to the concept and this is now being further developed in the form of a full feasibility analysis.
2. a micro initiative—develop a successful soybean marketing association in eastern Cambodia. The project team has been working with the Ta Ong Soybean Association (TSA) in Kampong Cham province. When we began work with TSA it was a non-functioning association with only 14 members. It now has 160 members (membership has been limited at this level). It is operating successfully as a microfinance institution, having made low-interest loans to about 1000 farmers, and is now looking to build its own dryer-silo and market its members' produce in Vietnam.

During this year, we also began the ***research*** phase in western Cambodia (involving mapping research on the marketing systems for maize and soybeans in this region). At the end of the year under review (in June 2006) we held a stakeholder workshop in western Cambodia to present our research findings and also to gain an understanding of what the stakeholders consider to be the major issues facing them. This stakeholder workshop represents the main transition point from ***research*** to ***action*** in our project in western Cambodia.

According to general consensus of the workshop participants, the major issues were:

1. existence of border fees
2. lack of access to good quality market information
3. lack of access to low-interest credit

The main action advocated by the workshop participants was the development of a silo association comprising the four new silos of western Cambodia (plus the fifth one when it is built). Such an association was viewed as an important catalyst for positive change on the major issues confronting the industry. Hence, our project team is now focused on facilitating the development of this association.

CIM/2003/030: Improving understanding and management of rice pathogens in Cambodia

Overseas Collaborating Countries	Cambodia
Commissioned Organisation	NSW Department of Primary Industries, Orange Agricultural Institute, Australia
Project Leader	Dr Eric Cother Phone: 02 63913886 Fax: 02 63913899 Email: ric.cother@agric.nsw.gov.au
Collaborating Institutions	Cambodia Agricultural Research and Development Institute Charles Sturt University, Australia
Project Budget	$399,998
Project Duration	01/07/2005 to 30/06/2008
ACIAR Research Program Manager	Dr Paul Fox

Project background and objectives

Rice is the main staple crop in Cambodia. Average consumption is about 160 kg per person each year. As a result rice is planted on 90 per cent of the total agricultural area. Rice is also the major agricultural income earner. Diversification of agriculture beyond rice is an important priority for Cambodia's government, but to achieve this several factors must be addressed, including raising rice yields so some land can be freed up to other agricultural pursuits.

Average yields for rice in Cambodia vary from wet to dry season. In the wet season yields are around 0.95 tonnes per hectare, almost doubling to 1.8 t/ha in the dry season. One factor constraining wet-season yields is disease, with this also limiting potential in dry seasons too. Current efforts to boost yields include double cropping of rice, a situation that also doubles the opportunities of diseases to spread.

Little is known about the spread or prevalence of important rice diseases in Cambodia. In part this is due to the lack of knowledge and expertise of plant pathology amongst Cambodian researchers. With more than 50 known diseases of rice capable of limiting yields, such knowledge is vital. What is known is the presence of brown spot, rice blast, false smut, kernel smut and bakanae. Building Cambodian capacity in plant pathology, focusing on rice, is needed to support both increased production and the options for agricultural diversification.

The primary goal of the project is to initiate and develop Cambodian training in general plant pathology and more specifically rice plant pathology to build Cambodia's long-term agricultural research capacity. The secondary aim is for Australian plant pathologists to gain a better understanding of the exotic diseases that have been identified as a threat to the Australian rice industry. It is intended that the knowledge gained from this project will help the Australian industry to maintain its comparatively low disease status and to prepare incursion management strategies.

Project progress

Year 1 (01/07/2005–30/06/2006)

Dr Vincent Lanoiselet was appointed as Project Scientist in late July 2005 and located at Charles Sturt University (CSU), Wagga Wagga. Merchandise for the plant pathology laboratory at CARDI was ordered from four suppliers and was delivered to Phnom Penh in various consignments in Jan–Mar 2006. Some of this equipment has yet to be unpacked. The equipment and consumables are listed in Appendix A of the annual report. Most was sourced in Australia except for the microscopes and laminar airflow cabinet, which were sourced via a European supplier in Cambodia.

Drs Ny Vuthy and Preap Visarto visited CSU, Wagga in Nov. 2005 to participate in 2½ weeks of training in plant pathology principles and methods, through a course structured to meet known and anticipated needs in Cambodia. The course was delivered by Drs Cother, Lanoiselet and Ash, based on material developed by Dr Lanoiselet and teaching aids from Dr Ash. The workshop covered informal lectures and videos, field visits to onion, tomato and rice crops in the Riverina, and laboratory practices.

A visit was made to the Agricultural Scientific Collection Unit at Orange to look at the plant pathology herbarium and for demonstrations in plant bacteriology techniques. A new plant pathology laboratory at Wagga Agricultural Institute was visited to discuss the principles of lab design and work flow. Drs Vuthy and Visarto were enthusiastic participants who were keen to be involved in hands-on laboratory techniques.

Two days were devoted to:
1) planning the workflow in the CARDI plant pathology laboratory, placement of equipment and infrastructure (shelves, cupboards and additional power points) that would need to be acquired for practical operation of the lab. These were overlaid on photographs of the lab taken during our visit in August 2004.

2) planning and logistics for the survey to be undertaken in Feb 2006. Content and structure of the training workshop to be held at CARDI during the Feb. visit to Cambodia, and an action plan for both parties was prepared. The target audience was deemed to include personnel from CARDI (10-12), DALLI (2), provinces (10), NGOs and AQIP (2) private consultants and farmers (2-4). Scope of instruction and method of delivery was discussed.

3) designing a specimen submission form for future use at CARDI (to be translated into Khmer for use in the February workshop).

Drs Vuthy and Visarto were given a laptop computer, copies of presentations in PowerPoint, many plant pathology reference books and numerous forceps, probes, needles and scissors for the CARDI lab.

Dr Lanoiselet resigned as Project Scientist on 3 Feb. 2006 to take up a position as Lecturer in Agronomy with CSU. However he will remain part of the CSU team involved with the project.

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

Overseas Collaborating Countries	Lao PDR, 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, Lao PDR 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. Lao PDR 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 Lao PDR are similar to those that have been identified in Thailand: development of insect pests and diseases during high humidity, lack of knowledge on how to select the best varieties and manage the crops, lack of nurseries, and lack of marketing studies or plans.

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

Project progress

Year 5 (01/07/2005–30/06/2006)

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 fruit 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 $6000–$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 of four Lao scientists and one farmer undertook a study tour of low-chill temperate fruit growing region of Queensland and NSW in October 2005.

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, to then grow to size, boosting the value of fish farming. But further advances are needed to ensure aquaculture itself remains a viable and sustainable option for smallholders and the environment alike. One component where advances could enhance sustainability is in fish diets. Most fish farmers do not buy commercial feeds—their high cost 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 required in juvenile fish is not always suitable for maintaining health in fully grown fish. Bio-energetic modelling, using these variables, can define protein and energy requirements and then guide the formulation of diets using local ingredients to match these parameters.

The overall aim of the project is to enhance the development of sustainable aquaculture using locally (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
- 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 38ºC. 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 10g to 500g. 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 have preliminary examination in August 2006, with further completion in November 2006. Progress against this objective is planned for Years 2 and 3 of the project.

Objective 3a: Transfer technology and extend information.
Workshops among the project participants were held in Can Tho in June 2005. These workshops 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 collected.

FIS/2002/075: Application of PCR for improved shrimp health management in the Asian region

Overseas Collaborating Countries	India, Indonesia, Thailand
Commissioned Organisation	CSIRO Livestock Industries, Australian Animal Health Laboratory, Australia
Project Leader	Dr Peter Walker Phone: 03-5227 5165 Fax: 03-5227 5555 Email: peter.walker@csiro.au
Collaborating Institutions	Mahidol University, Thailand Directorate General Aquaculture, Indonesia Network of Aquaculture Centres in Asia Pacific, Thailand Agency for Marine and Fisheries Research, Indonesia
Project Budget	$715,920
Project Duration	01/01/2005 to 31/12/2007
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Shrimp farming, or culturing, is a profitable industry. Successful culturing provides income and employment for smallholder farmers, as well as those working in hatcheries, larger-scale farms, feed mills and processing plants. Most of this has flow-on effects as income is redistributed throughout the usually poor rural communities, many located in coastal regions that practice shrimp culturing.

In addition to these benefits farming of shrimp is sustainable. This relieves the pressure placed on wild populations being harvested at unsustainable catch levels, motivated by reaping the potential income on offer. Thailand leads the world in farmed shrimp production, with Indonesia and India, like many other countries in Asia, both major and growing producers.

For the past decade the Asian industry has been limited by disease outbreaks. Several have been serious enough to cause declines that if continued unabated would threaten the industry. Two diseases in particular, white spot syndrome virus (WSSV) causing white spot disease and yellow head virus (YHV) have caused these declines. Past ACIAR research has developed polymerase chain reaction (PCR) and epidemiological tests to identify the diseases. These are used to detect the viruses in seed stock and live shrimp respectively. Despite these being widely adopted, outbreaks continue, and a slow growth syndrome has become more prevalent, prompting further research into PCR use and its role in ongoing farm management.

The project will focus on:

- reducing the risk of White spot disease in shrimp farms through the application of PCR-based detection tests and epidemiological probes.
- reducing the risk of yellow head and other shrimp diseases in shrimp farms through application of PCR-based detection tests and epidemiological probes.
- improving the effectiveness of PCR-based viral screening in hatcheries and service laboratories in India, Indonesia and other countries in the Asian region.

Project progress

Year 1 (01/01/2005–31/12/2005)

Objective 1: Reduce the risk of WSD in shrimp farms through the application of PCR-based detection tests and epidemiological probes.
A major experimental component of this project is a large longitudinal study of shrimp ponds in India. The aim is to obtain information on the quality of PCR screening results available to farmers and to use molecular epidemiological analysis to trace the sources of disease outbreaks in ponds. The longitudinal study was conducted at a NACA/MPEDA/ACIAR study area in the West Godavari District of Andhra Pradesh. The site comprises 27 farm clusters around 14 villages between Bhimavarum and the mouth of the Godavari River. Farmers participating in the study are members of 'aquaclubs' formed as part of an ongoing extension program of best management practices. The farms were stocked in February–April 2005 with PCR-screened post-larvae (PLs) obtained from local hatcheries. Some farmers employed nursery ponds to improve survival rates during grow-out. Each nursery pond served to seed a number of grow-out ponds at the same location. A total of 27 nursery ponds were sampled on stocking; 19 of these were also sampled at harvest. A total of 457 grow-out ponds were sampled at the time of stocking. Samples were also collected during disease outbreaks from 14 ponds, emergency harvests from 52 ponds, and planned harvests from 277 ponds. Wild shrimp were collected from 23 ponds and crabs from 65 ponds during the period between stocking and harvest. Laboratory analyses on all of these samples will be reported during the next period.

Objective 2: Reduce the risk of yellow head and other diseases in shrimp farms through the application of PCR-based detection tests and epidemiological probes.
Monodon slow growth syndrome (MSGS) is a newly emerging disease that has impacted severely on *P. monodon* production in Thailand with losses in 2004 estimated at ~40 million baht. Work at Centex Shrimp in Thailand has suggested that the disease is infectious. Examination of shrimp displaying signs of the disease has identified three infectious agents—a yellow head virus genotype, a new shrimp virus (Laem Singh virus—LSNV) and a microsporidium. It is not yet clear which, if any, of these agents is the primary cause of MSGS. LSNV has been partially sequenced and a PCR detection test developed. Using this test, the virus can be detected in healthy shrimp as well as those showing signs of slow growth. In June–July 2005 Dr Sitidilokratna of Centex Shrimp visited CSIRO to apply the PCR detection test to *P. monodon* samples from throughout the Indo-Pacific region. LSNV was detected in shrimp from Thailand, Malaysia and Indonesia but not in samples from Australia, India, Vietnam, Mozambique or Fiji.

Objective 3: Improve the effectiveness of PCR-based viral screening in hatcheries and service laboratories in India, Indonesia and other countries in the Asian region.
The project also aims to enhance technical capabilities in India and Indonesia through PCR training workshops and the inter-calibration of PCR testing performance between laboratories. The first PCR training workshop was held in Bogor, Indonesia in August 2005. The workshop was attended by 24 participants from laboratories throughout the Indonesian archipelago. A second PCR training workshop was held at CIBA in India in October 2005 with financial support from MPEDA. The workshop was attended by 25 participants from hatcheries and government, private and research laboratories in seven States, and three international participants (Sri Lanka, Bangladesh and Myanmar) supported by ACIAR. Each workshop included practical sessions and open seminars which were attended by representatives from the research, government and industry sectors.

Mr Agus Sunarto and Mrs Isti Koesharyani from the Fish Health Research Laboratory, Jakarta, and Mrs Christina Handayani from the Center for Brackishwater Aquaculture Development, Japara, Indonesia visited AAHL in July 2005. These scientists assisted with preparation for the training workshop in Bogor and participated as trainers in the workshop. They were also instructed in the use of real-time PCR during the visit to AAHL.

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 (GRIM), 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. A follow-up visit was made by DPI&F staff to GRIM in April 2006 to continue the development of larval enzyme analyses using material supplied by GRIM and to initiative collaborative experiments:

- Sampling protocols for reef fish larvae for digestive enzyme analysis were developed and tested successfully.
- A time series of *Plectropomus leopardus* larvae and juveniles was sampled to provide baseline data on digestive enzyme ontogeny in this species.
- Samples of different-sized *P. leopardus* larvae at the same age were sampled to provide better information on the impacts of size stratification amongst same-age cohorts of larvae.

A series of follow-on experiments was 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. 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 not as good as 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.

Asia-Pacific Marine Finfish Aquaculture Network

Five editions of the Marine Finfish Aquaculture e-Newsletter were produced (No's 27–31). There are currently 1,130 subscribers to the e-Newsletter. Four editions of the AMPFAN e-Magazine (No's 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. A training course was organized by Krabi Coastal Fisheries Research and Development Centre (CFRDC), DOF from 30 June to 2 July 2005 on basic farm operation of better management practice. Twelve cage fish farmers attended this course. CFRDC supported training facilities, staff, dormitory and technology, and NACA supported training materials and meals. 'A Guide to Small-scale Marine Finfish Hatchery Technology' has also been translated into Vietnamese.

On 24–25 November 2005, Mr. Hassanai Kongkeo and Mr Koji Yamamoto (NACA) visited the tsunami-affected fish farming communities of Koh Yao Noi (Phang-nga Province) and Koh Lanta Noi (Krabi Province), Andaman coast (where NACA has been working on fish farm rehabilitation) and disseminated the Thai versions of both guides.

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

Overseas Collaborating Countries	Cambodia, Lao PDR, 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, Lao PDR 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 (MRB) is home to fisheries which provide food security for approximately 60 million people spread across several countries. Despite their importance management of these fisheries is rudimentary at best. The Mekong River Commission (MRC), formed under the cooperation of the four countries sharing the lower parts of the basin, have begun to focus on achieving sustainable fisheries management to ensure food security is maintained, while also factoring in growing development pressures on the river. The basin offers a wide range of agricultural and industrial development opportunities. Hydrological power development is one such opportunity that threatens fisheries, while the importance of the river as a trade link between the six riparian countries through which it runs, is also likely to increase. Population increases will continue to put further pressure on the surrounding environment and river system itself, as well as on the capabilities of Mekong fisheries.

Management of these fisheries is complicated by the high level of diversity of fish species. Sustainable management practices can vary between species depending on ecology and life histories. The MRC has initiated extensive studies of the ecology of a number of important fish species to understand ecology and life histories better. The use of genetic methodologies for identifying discrete gene pools has not been used in the Mekong. Elsewhere these techniques are being applied to 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 MRB.

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

Overseas Collaborating Countries	Lao PDR, 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 Lao PDR, Lao PDR 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 1 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, Lao PDR 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 Lao PDR, 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 on growth and survival. More detailed assessment will be carried out by project personnel during the reporting period.

6. In Queensland DPI&F has 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).

HORT/2003/045: Improvement of vegetable production and postharvest management systems in Cambodia and Australia

Overseas Collaborating Countries	Cambodia
Commissioned Organisation	NSW Department of Primary Industries, Yanco Agricultural Institute, Australia
Project Leader	Mr Mark Hickey Phone: 02 69512523, Mobile 0427401474 Fax: 02 69512692 Email: mark.hickey@agric.nsw.gov.au
Collaborating Institutions	Cambodia Agricultural Research and Development Institute Department of Agronomy and Agricultural Land Improvement, Cambodia Department of Planning, Statistics and International Co-operation, Cambodia
Project Budget	$873,926
Project Duration	01/07/2005 to 31/12/2008
ACIAR Research Program Manager	Mr Les Baxter

Project background and objectives

The Cambodian Government has been keen to support a growing trend of crop diversification amongst farmers. Traditionally rice has been the main crop grown, but diversification has increased since the country attained rice self-sufficiency. Despite this, vegetable production remains very low—largely due to unreliable supply of seed, high input costs and a lack of knowledge of postharvest handling. Per capita consumption is amongst the lowest in Asia, so the industry has a large potential for growth. The most urgent requirements for vegetable improvement in Cambodia have been identified as:

- availability of cultivars with resistance to diseases, pests and high temperatures
- enhanced understanding of the deficiencies and options for improvement of vegetable supply chains
- practical and low-cost technologies to improve crop yields and quality
- postharvest handling and pest management to reduce pesticide residues and provide more effective control measures.

The World Vegetable Centre (AVRDC) has active breeding and crop improvement programs in tomatoes and chilli that were suitable for inclusion as target crops in the project.

The three main project objectives are:

1) to map supply chain constraints, devise improvements and incentives for improving product marketability in the Cambodian vegetable industry;

2) to develop and demonstrate improved production and postharvest strategies that will underpin quality improvement and industry development;

3) to improve R&D capacity in Cambodia in vegetable research, by ensuring maximum sharing of technology and know-how between Australian, AVRDC and Cambodian partners.

Project progress

Year 1 (01/07/2005–30/06/2006)

Project activities commenced in October 2005 with a project planning workshop in Phnom Penh. All project partners including NSW Department Of Primary Industries (NSW DPI), Cambodian Agricultural Research and Development Institute (CARDI), Department of Agronomy and Agricultural Land Improvement (DAALI) and the World Vegetable Centre (AVRDC), were in attendance. The overall objective of this project is to improve the profitability and quality of Cambodian vegetables for the domestic market and to develop sustainable system improvements which can be readily adapted to other commodities and across the transport, storage, processing and export sectors.

At the workshop, dry season activities, including research station and field trials for tomatoes were designed, sites selected and survey questionnaires drafted. Several projects including the AusAID-funded Agricultural Quality Improvement Project (AQIP), and non-government organisations, including Intermediate Development Enterprises (IDE) and CARE Cambodia, were also consulted, and joint activities including evaluations of the IDE low-tech drip irrigation system were planned.

The dry season research trials included the following;

- two replicated tomato variety trials at DAALI and CARDI Research Stations
- one replicated on farm tomato variety trial
- one non replicated on farm tomato and chilli variety demonstration (shared with ADB/DAALI project)
- one replicated tomato nitrogen rate trial (DAALI)
- one non-replicated tomato drip irrigation trial (DAALI)
- one replicated processing tomato trial (Australia)

Postharvest assessments were carried out on the two replicated variety trials and the nitrogen trial. The tomato variety entries included AVRDC varieties compared to existing grower varieties and as yet untested hybrid varieties, which were donated to the project by commercial seed companies. The trial sites varied in soil type and management system, and therefore the results gave good indication of suitability of the entries. Some of the traditional varieties, although relatively high yielding, have poor shelf life and other undesirable traits such as a tendency to split and crack.

In terms of fruit yield, the best performing open pollinated lines include CLN 1462A and CLN2764 and the traditional line K1, and the best performing hybrids Dalila (East West Seeds), HET2 (AVRDC) and Jetayu (Marco Polo Seeds). Overall, the best performing line at Dey Eth was CLN1462A, with the fruit yield significantly higher than all other varieties (at the 5% level), although higher plant populations probably influenced yield. Some of the commercial hybrid varieties, including Dalila and Jetayu performed consistently well at both sites. Further trials with these varieties would be required to determine if they perform consistently well enough to justify higher seed prices generally paid for hybrids. There was some variation between results at the CARDI and Dey Eth sites, the most notable being the poorer performance of CLN 1462A at CARDI.

The postharvest trial evaluated the fruit quality and postharvest storage life of the 13 tomato varieties. Ly Serievuth from DAALI has produced a draft tomato information sheet in Khmer language, based on the outcomes from the tomato variety work in the ACIAR project this year. It will be distributed to farmers, resellers and advisers working with vegetable crops.

A replicated trial at Dey Eth Station comparing the effect of various rates of nitrogen on fruit yield and quality has been analysed. Although there was no significant difference between the 100 to 180kgs/ha rates of nitrogen, there was a linear response to the level of nitrogen applied, with higher levels of applied nitrogen increasing marketable yield. Early results from the postharvest analysis suggest there are no differences in shelf life between the treatments.

Trials evaluating post-harvest deterioration of chillis focused on the potential impact of resistance to anthracnose, not only in increasing harvestable crop, but in extending the crops shelf-life with minimal losses.

Drip irrigation trials at Kbal Koh were successful and showed some promise for commercial use of the system. The drip system out performed the conventional hand-watered plots in both yield and water use efficiency. Total marketable fruit yield from the drip block (12.62 tonnes/ha) was 26% higher than the hand-watered block (9.98 tonnes/ha). Average fruit weight from the 1st pick of the drip block was also higher at 83.2 g compared to 71.0 g for the hand watered block. Water use efficiency was higher in the drip block at 5.63 tonnes/ML compared to 3.18 tonnes/ML for the hand-watered plots.

Postharvest training for CARDI, DAALI staff and two participants from Lao PDR on setting-up postharvest trials, quality and shelf life assessment was provided during the Australian team's February visit. This training coincided with harvesting time for the tomato variety trials enabling skills to be implemented immediately with the setting up of the postharvest evaluation of the variety trial and fertiliser trial.

Surveys were conducted in Saang, Kiensvay and Mok Ampil districts in Kandal province, with the tomato grower survey of 50 farmers completed in June, complementing the earlier ADB survey of market agents, collectors and transporters in late 2005. The chilli survey is currently being drafted, and will be conducted in the next few months. In the ADB project (which we collaborate with closely) survey, 91% of farmers sold tomatoes to collectors, with only 9% selling directly to wholesalers; 77% of tomatoes handled by the collectors were then on sold to wholesalers, with the remaining product sold to street vendors. Seventy-seven per cent of tomatoes sold to wet market vendors arrive in plastic bags, with the remainder packed in cartons, bamboo baskets or Styrofoam boxes (8% each). 60% of farmers also reported losses at the farm level due to spoilage.

As part of the Australian component of the project several activities were undertaken including;

- a replicated processing tomato variety trial in Barooga, south western NSW
- a survey of Cambodian tomato growers in Western Sydney
- a consultation meeting with the Cambodian vegetable growers
- planning for three 2006/07 cherry tomato grower trials

A drip irrigated replicated processing tomato trial was established at Barooga. The purpose of the trial was to provide practical training for Cambodian scientists in management of on-farm experiments. The Cambodian scientists participated in the harvest of the trial and fruit quality analysis at the Yanco laboratory in late March 2006. While the results were not critical to the project, the data confirmed larger non-replicated machine harvest trial results. H9035 was the best performer in terms of fruit yield at 132 tonnes/ha, while AB2 had the highest total soluble solids content at 5.7% TSS.

Following a meeting with Cambodian growers in February, at which one their priority issues identified was cherry tomato varieties and their postharvest performance, three grower trials in western Sydney and one glasshouse trial at Gosford has been planned for 2006–07.

In March and April 2006, four scientists (two from CARDI and two from DAALI) visited Yanco Agricultural Institute and Gosford Horticultural institute as part of a project study tour. The scientists received training in a range of field and postharvest trial management methods, data management and analysis, and crop agronomy/breeding. A tour report was authored by the participants.

LPS/1998/026: Lucerne adapted to adverse environments in China and Australia

Overseas Collaborating Countries	China, Lao PDR
Commissioned Organisation	South Australian Research and Development Institute, Plant Research Centre, Australia
Project Leader	Dr Geoff Auricht Phone: 08 8303 9498 Fax: 08 8303 9607 Email: auricht.geoff@saugov.sa.gov.au
Collaborating Institutions	Department of Agriculture, Western Australia, Australia University of Tasmania, Australia Gansu Agricultural University, China Shandong Academy of Agricultural Sciences, China Beijing Forestry University, China Chinese Academy of Agricultural Sciences, China Gansu Grasslands Ecological Research Institute, China
Project Budget	$1,283,864
Project Duration	01/01/2001 to 31/12/2006 (Project extended from 01/01/2005 to 31/12/2006)
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

Sustainable agricultural production is vital for China. As the country develops, demand for animal products is increasing. However, the country faces a severe shortage of forage, as well as many environmental problems such as increasing soil salinity, acidity and erosion. The vast grassland areas are not very productive, partly due to inappropriate management but also because of unimproved pasture plants and deforestation. Australia also has related problems of salinity and waterlogging caused by a lack of deep-rooted perennials plants to keep watertables low. Part of the solution to these problems may come from lucerne, which is a nutritious, productive perennial forage legume with the potential to improve animal production and soil stability, and from lower watertables. Interest in lucerne is growing, often in places where it was previously considered unsuitable.

Currently, lucerne is sown in 14 provinces in China, and covers 1.33 million ha. It also grows wild in other regions of the country. However, it could be grown far more widely. But the current lucerne is under-utilised, because of the poor performance of the cultivars grown, coupled with a lack of suitable technology and quality seed. A diverse base of germplasm is already available for lucerne, with a range of tolerances to adverse soil and climatic conditions. But research is required to develop lucerne germplasm specifically adapted for the situations in China and Australia. This large project will target salt, waterlogging, acid/aluminium and cold tolerance by developing new screening techniques and using them to identify tolerant genotypes.

The project aims to produce lucerne varieties that are adapted to environmental stresses relevant to China and Australia through the development of germplasm and novel screening techniques.

Project progress

Year 5 (01/01/2005-31/12/2005)

Acquisition and field testing of germplasm
Germplasm characterisation (project germplasm and that from project supported collection missions) was completed and seed produced ready for distribution. Measurement and assessment of trials has continued at all sites in China and Australia, using the revised measurement protocol. All the Chinese field trial results have now been collated in Adelaide for further analysis. Further trials were established in Lao PDR with the collaborators establishing eight trials across two provinces, three districts and six villages.

Developing novel screening techniques
Aluminium screening continued with the several generations of progeny now selected and tested against the parent material. The results of these experiments were exciting with each subsequent generation having increased tolerance over the previous generation. Further selections are continuing with the aim of releasing a cultivar in 2007. The evaluation of the material in pot experiments with acid soil continued, as well as field trials of the early acid-tolerant progeny. The acid/aluminium screening method has been adapted to screen both plants and rhizobia for nodulation at low pH. This is an important advance as acid-tolerant rhizobia are important for the success of lucerne in acid soils. Salinity work continued in Tasmania with a range of parameters measured to characterise the response to salt stress of genetically diverse plant material. Results were interesting in that material with different genetic backgrounds appear to have different tolerance mechanisms and this may reflect adaptation to differing levels of salt stress. Christiane Smethurst had her PhD thesis accepted.

Delivering well-adapted germplasm to seed producers and breeders
With the extension of the project imminent it was decided to continue trial measurement for another year before making recommendations. The aluminium tolerance screening has already supplied material to breeding programs and retested the progeny of this material. Further selection cycles will continue in 2006. Early generation progeny were included in evaluation trials in 2005.

Training Chinese researchers, publish lucerne improvement findings and extension course
The 5th project meeting was held in Beijing in May 2005. As with previous meetings part of the meeting was devoted to methodological considerations, theoretical and practical issues involved in trial measurement. Adjacent to the project meeting, a short course was held on lucerne breeding methodology. The result of this course was the development of a breeding strategy for each of the collaborators. The Beijing meeting was followed up with discussions at the project trial sites during the field visits. A number of project-related papers were published in Chinese journals. Another paper was published from the screening work. Project research was also presented at the International Plant Nutrition Colloquium in Beijing. Project activities and research have featured in a number of articles in Australian electronic and print press. Funding was again sought from the DEST China-Australia fund to support an extension workshop that would result in the publication of a book on lucerne use in China. The Australian model for this publication, *Success with Dryland Lucerne*, was translated into Chinese.

LPS/2005/052: The development of cattle and buffalo breeding strategies and activities based on BREEDPLAN in Thailand

Overseas Collaborating Countries	Thailand
Commissioned Organisation	Agricultural Business Research Institute, Australia
Project Leader	Mr Jamie Allen Phone: 61 2 6773 3023 Fax: 61 2 6772 5376 Email: jack.allen@abri.une.edu.au
Collaborating Institutions	
Project Budget	$50,000
Project Duration	01/05/2006 to 31/12/2006
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

A previous ACIAR project helped Thailand to establish a national system of recording and evaluating the breeding and performance of beef cattle and buffalo. This system which has been run by the Department of Livestock Development (DLD) uses a PC software system—Herd Magic to record the data for genetic evaluations to rank animals for genetic merit and monitor genetic progress within and across herds. This new ACIAR project proposes to develop the HerdMASTER program—the latest tool of Microsoft to have Thai language capability to collect data more efficiently. This work will specifically alter HerdMASTER screens to have Thai language labels, convert online help documentation and develop basic help into Thai language and convert existing Thailand Herd Magic systems to HerdMASTER. This proposal will include the training of a Thai officer from DLD in the use of the package.

Project progress

First progress report due in 2007.

LWR/2001/051: Assessing land suitability for crop diversification in Cambodia and Australia

Overseas Collaborating Countries	Cambodia
Commissioned Organisation	Murdoch University, School of Biological and Environmental Sciences, Australia
Project Leader	Associate Professor Richard Bell Phone: 08 9360 2370, 08 9360 6000 Fax: 08 9310 4997 Email: rbell@murdoch.edu.au
Project Web Site	http://wwwenvironment.murdoch.edu.au/welcomestatement.html
Collaborating Institutions	Department of Agriculture and Food, Western Australia, Australia Cambodia Agricultural Research and Development Institute
Project Budget	$915,463
Project Duration	01/01/2003 to 30/06/2007 (Project extended from 01/01/2006 to 30/06/2007)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Crop diversification can alleviate poverty by increasing income and improving nutrition for farm households. In the lowlands of Cambodia there is potential to diversify from the traditional wet season rainfed rice system by double cropping (with rice and legumes) using the abundant shallow groundwater for irrigation. Similarly, in the uplands, relatively large areas of land are available for the expansion of cropping and could be used to grow field crops and fruit and nut trees. To ensure that crop diversification is effective, information is needed on soil and climate constraints, and potential environmental impacts, to assess the suitability of land for particular crops. The land resource studies and soil maps needed for assessing land suitability are generally not available for Cambodia.

This project aims to facilitate crop diversification in Cambodia and Australia by assessing land suitability for growing crops such as legumes and field crops in lowland and upland areas of Cambodia respectively, and pulses in southern Australia.

Project progress

Year 3 (01/01/2005–31/12/2005)

Our project is concerned with assessing land suitability for crop diversification in Cambodia and Australia. While clearly there are major differences between the rice-based agriculture of Cambodia, and the wheat-based agriculture of south-west Australia, there are significant common interests between the two partner countries. Agriculture is dominated by a single cereal crop in each case, and whereas opportunities for diversification appear to exist, there are key blockages in adoption. The underlying premise of our work is that a more explicit description of the biophysical and socio-economic limiting factors through land suitability assessment will help to improve adoption of crop diversification. Hence the methodology of land suitability assessment is a common interest in Cambodia and Australia.

In Cambodia, the key activities and outputs of the last 12 months work were:
The soil database of Cambodia was updated and now includes 163 soil profile records across Cambodia including 92 from this ACIAR project. Thirty-four of the profiles have accompanying soil chemical data, of which 23 were contributed by the present project. The complete database was made available to the International Soil and Reference Information Centre (ISRIC) in August 2005 to add to their soil and terrain database (SOTER): ISRIC has funding from GTZ to conduct a national reconnaissance land resource assessment of Cambodia, based mostly on analysis of spatial data, to produce a replacement for the Crocker 1961 national soil map at 1:500,000 scale.

Semi-detailed soil surveys completed for Ou Reang Ov–Kampong Cham, Tramkak–Takeo and Banan–Battambang. Soil samples from the profile of four sites representing the main upland soil types of Banan were analysed in Australia for chemical properties, and results added to the soil database of Cambodia. The soil-landscape map of Tramkak district in Takeo was finalised in June 2005. Soils map of the Banan district of Battambang was completed following ground-truthing in June 2005. Reports of soils and landscapes for each of the districts were completed in November and will be distributed by CARDI.

A new soil group was proposed for the Cambodian Agronomic Soil Classification (CASC) to recognise the distinctive properties of brown gravelly soils found on the slopes of the basaltic plateau of eastern Cambodian, and named the Ou Reang Ov Soil group. A new calcareous phase of the Kompong Siem Soil group was also proposed to recognise the distinctive constraints for non-rice crops on the black clay soils formed on limestone in Battambang compared to the black clay soils formed on basalt that are common in eastern Cambodia..

A farmers' survey established a baseline of current field crop production, as well as the associated common management practices. The field crops under investigation were chilli, maize, mungbean, peanut, sesame and soybean. Farmers were surveyed in the districts of Banan (Battambang), Ou Reang Ov (Kampong Cham) and Tramkak (Takeo) using a questionnaire that elicited information on farm characteristics, cropping practices, soils, limiting factors for field crop production and their place in the farming systems. Soil types differed amongst the three districts. Banan had the most diverse soils and crop yields exceeded those in other districts. Cropping was also most diverse in Banan. However, in fertilizer use, weed and pest control, there was a distinct difference between Banan and the other districts. Tramkak had the greatest prevalence of sandy soils and much lower yields of field crops. No weed control was practised for a larger percentage of field crops in Tramkak, and these farmers generally applied chemical fertilizers and manure to their field crops.

On-farm trials The aim of these trials was to establish a benchmark for yield potential in different crops and how these would vary across soils in the three districts, and between early wet season and main wet season sowing. Based on 2004 results, we draw the following conclusions:

- Early wet season crops were more risky with successful establishment in 20–80 % of cases compared to 40–100 % success in the main wet season. Maize and peanut were the more reliable crops with 70–100 % success in establishment, while sesame was least successful with establishment in 20–40 % of cases.
- Maize and mungbean managed to thrive on all soil types, but they produced yields only 35–40% of the estimated potential yield levels.
- Peanut was most productive on Kampong Siem, Toul Samroung, and Kien Svay soils producing yields equivalent to 63–92% of the potential yield (2–3 t/ha).
- Soybean was fairly productive on Kien Svay and Kampong Siem soils producing yields equivalent to 66–81% of the potential yield.
- Sesame was not promising on any of the soil types. Factors such as time of sowing, seed quality, water availability, insects and weeds, and fertiliser application techniques must be carefully considered if sesame is to be grown on any of the studied soils.

Considering all crop species in 2004, the ranking of soils according to relative crop yields was as follows: Kien Svay and Kompong Siem soils > Labanbsiek > Toul Samroung and Prey Khmer > Ou Reang Ov > Prateah Lang > Kompong Siem calcareous. For individual crops, rankings varied, for example, mung bean yielded very poorly on the Labansiek and Kien Svay soils but had highest yield on Prey Khmer soil.

All yields in 2003 were low, reflecting late sowing in the early wet season, and inexperience in crop management with these species. Hence, the 2003 results have not been examined in depth. Results from the 2005 on-farm trial are still being analysed.

A land capability assessment survey of farmers was completed in 2004 in Ou Reang Ov, Tramkak and Banan districts. Critical information reported by farmers on: soil classification, soil erosion, crop establishment, sowing rules, water condition in the fields and the soil fertility of different soil types, can be drawn from the survey. Ninety-four per cent of the interviewees in Ou Reang Ov District owned fields with loamy soil texture, but almost 80% owned fields with KC2 map unit, which was classified as Ou Reang Ov Soil group. This is a brown clay loam on sloping land with a high percent sub-soil gravel. The majority of soils identified by the farmers in Tramkak were sandy loam, located mostly in TK2, TK6 and TK4 in the district soil map and corresponding to Prateah Lang and Prey Khmer classifications.

Farmers in Banan District identified their fields as sandy loam, sandy and loamy soil and they were found in Ba2 and Ba11 in the soil map and classified as Kien Svay and Kompong Siem Soil groups. The fields that experienced erosion in Tramkak were on the flat land or very gently sloping land. Erosion reported in Banan also occurred only on the flat land. In Ou Reang Ov District fields were more sloping compared to the other districts and experienced no reported erosion.

Soil texture, gravel content and structure were likely to be factors controlling soil erosion. Kien Svay and Prey Khmer soil types were the most popular for chilli. Peanut was cultivated predominantly on Prateah Lang and Ou Reang Ov soil. The early wet season crops were mainly sown in April in Ou Reang Ov and Banan but most farmers in Tramkak preferred to sow maize in May rather than April. July was the preferred time for wet season crops for all three locations though farmers in Tramkak also planted peanut in August.

Several factors were reported to influence decision-making for crop selection such as: expected yields, traditional practices, insects, land preparation, harvest constraints, water logging, overlapping growing seasons and water shortages. Sufficient rainfall was the main factor influencing sowing date. When faced with unfavourable conditions for sowing a crop due to delayed rainfall, the majority of farmers left their fields fallow, otherwise alternative crops with drought tolerance and short duration varieties were the options and only few farmers proposed to replant the same crops. Water standing was reported for the flat and very gently slope fields for short periods after heavy rainfall. Except for 10% of fields in Ou Reang Ov with high clay percentage, severe waterlogging was not reported, suggesting the fields were able to drain freely. In contrast, drought was a serious constraint because the soils dry out quickly after experiencing no rain for only five days, especially in the sandy fields.

Most farmers across the three locations considered the fields to be medium–good soil fertility. Surprisingly, there were no fields rated as good soil fertility in Banan even though we identified Kien Svay as producing moderate to high yields in the on-farm trials.

Soils of Ou Reang Ov This investigation was to identify the range and distribution of soil types in the Ou Reang Ov district, Kampong Cham province and to determine the limiting factors of these soils. The study area was on uplands of mid Pleistocene basaltic flows and associated lowland paddy soils of old and recent alluvium/colluvium. Soil classification was completed by detailed profile descriptions using World Reference Base descriptors. These were combined with digital air photos, a digital elevation model, Landsat TM satellite images and expert knowledge to create 10 soil-landscape map units. Chemical and mineralogical properties of the detailed soil profiles were analysed.

Soils of Tramkak Soils and landscapes in Tramkak district Takeo province were investigated by a semi-detailed soil survey. A soil-landscape map was developed for the district in which 9 units were recognised. The main soil-landscape units in order of their likely capability for non-rice crops were: Prey Khmer, Prateah Lang, and Bakan Soil groups.

Soils of Banan Soils and landscapes in Banan district Battambag province were investigated by a semi-detailed soil survey. A soil-landscape map was developed for the district in which 14 units were recognised. The main soil-landscape units in order of their capability for non-rice cropping were: Kein Svay an alluvial loam along the Sangke River, the brown phase of Toul Samroung Soil group on gently undulating plains and a calcareous phase of the Kompong Siem Soil group that develops on sloping land surrounding limestone hills. All soils are prone to waterlogging during periods of heavy rain. Otherwise the Kein Svay has few chemical or physical limitations for non-rice crops.

The land capability classification framework used in WA was applied in Cambodia, and the land qualities re-calibrated as necessary. In particular, the depths for limiting sub-soil land qualities were rated in the 20-50 cm depth range in alignment with the Fertility Capability Classification previously used in Cambodia for CASC.

Land capability for Ou Reang Ov district Land capability was determined for non-rice field crops on the main soil-landscape mapping units on basaltic terrain in Ou Reang Ov district, Kampong Cham province. Limiting factors were identified, and land qualities rated for the soil types identified previously in a soil survey of the district. Despite a range of different limiting factors, the clayey soils which are commonly found in eastern Cambodia associated with basalt appear to have fair to good capability for cropping. Their relative proximity to markets and good-quality all-weather roads adds to the potential for crop diversification.

Land capability for Tramkak district Land capability was determined for field crops in the predominantly sandy terrain of Tramkak district. Limiting factors for crops were identified, and land qualities rated for the soil types identified previously in a soil survey of the district. The deep sandy Prey Khmer soils have fair capability for cropping with low soil water storage and aluminium toxicity being the most likely limiting factors. By contrast, the Prateah Lang soil has poor capability due to waterlogging and low soil water storage, and the Bakan soil was not recommended for non-rice crops due to waterlogging and inundation risk.

Rebecca Ovens, an *Australian Youth Ambassador for Development* submitted her Honours thesis in February 2005, Her study was an investigation on the groundwater seepage areas of Kampong Cham, and their implications for crop diversification. In the basaltic terrain of Kampong Cham province groundwater seeps are known to occur around the outskirts of basaltic plateau, and have been suggested to hold significant potential for irrigation of diversified crops.

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

Overseas Collaborating Countries	Lao PDR, 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 Lao PDR World Vision Foundation, Lao PDR 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 Lao PDR, Thailand and Vietnam. Results arising from a mature or completed ACIAR project activity which are suitable for farmer-level extension are integrated into an active WV project in particular provinces 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 Lao PDR 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)

In 2001, the collaborative ACIAR-World Vision Low-Cost Fish-Raising Promotion and Development project set out to promote fishery development in North East Thailand using appropriate, low-cost production methods. It was expected that within five years the results of the project could provide self-sufficiency for protein intake in the Surin and Udon Thani target areas. The external review in September 2003 confirmed that significant progress had been made to achieving both this objective and the objective of disseminating the techniques on low-cost fish-raising. An extension was granted in 2004 to not only disseminate the results further through the two provinces, but also address some of the issues around feed production optimisation, marketing and fish processing.

Extension objectives
The overall goal of the project is to improve both the nutrition and incomes of rural and peri-urban families in three target districts of Udon Thani and Surin Province, Thailand, through:

- optimisation of fish feed production;
- growth of two culture species (nil tilapia and catfish);
- promotion of appropriate management techniques for cage and backyard ponds;
- emphasis on 'training the trainer' in order to improve and increase sustainability.

Progress summary
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. Fifty thousand 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 resistant. 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 chillis, ginger, lemon grass, banana, lemons, coconut and mango. The project has continued with fish processing training, for value-added fish products.

PLIA/2006/012: Livestock health and vaccines in Cambodia and Lao PDR: scoping study and economic assessment

Overseas Collaborating Countries	Cambodia, Lao PDR
Commissioned Organisation	Centre for International Economics, Australia
Project Leader	Dr Robert Warner Phone: 02 6245 7800 Fax: 02 6245 7888 Email: bwarner@theCIE.com.au
Collaborating Institutions	
Project Budget	$100,800
Project Duration	01/06/2006 to 29/09/2006
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

ACIAR's Animal Health Program has identified the policy and economic environment as an important aspect of livestock development in Lao PDR and Cambodia. Therefore it was decided that the Policy Impact Linkages and Assessment Program should commission a thorough review of this environment as a prelude to supporting effective development of several Animal Health projects, namely AH/2005/084 (Improved supply and quality of livestock vaccines in Lao PDR), AH/2005/086 (Best practice control of diseases in cattle, Lao PDR and Cambodia) and AH/2006/025 (Improved risk assessment for transboundary disease in Lao PDR and Cambodia).

Project progress

First progress report due in 2007.

SFS/2000/007: Farmer-based adaptive rodent management, extension and research system in Cambodia

Overseas Collaborating Countries	Cambodia
Commissioned Organisation	University of Queensland, School of Animal Studies, Australia
Project Leader	Mr Luke K-P Leung Phone: 07 5460 1264 Fax: 07 5460 1444 Email: lkl@sas.uq.edu.au
Project Web Site	http://www.communityzero.com/camfarmers
Collaborating Institutions	Cambodian Department of Agricultural Extension, Cambodia Cambodia Agricultural Research and Development Institute, Cambodia
Project Budget	$515,973
Project Duration	01/07/2001 to 31/12/2006 (Project extended from 01/07/2005 to 31/12/2006)
ACIAR Research Program Manager	Dr Simon Hearn

Project background and objectives

The rat is the most important pest of rice in Cambodia. Rat problems are likely to get worse with increased cropping intensity. Farmers have traditionally managed rats in various ways e.g. using zinc phosphide bait, trapping, digging burrows, hunting, and plastic fences. Sometimes, this has been supported by a bounty on rat tails. There is scope to improve existing practices both by improving the techniques of rat management used by individual farmers and by greater attention to concerted action by communities. Previous work in Cambodia showed the usefulness of community-based approaches based on the concerted action of individuals pursuing their own practices and on novel technology (such as the active trap barrier system—TBS), and managing the latter as a community resource. TBS technology has been developed elsewhere in the region but the economic and social aspects of this technology are poorly understood.

Management of the TBS as a common property resource (i.e. at a community level) may provide a means to overcome this problem. This also means that the technical aspects of the technology and the social arrangements that support it have to be melded together. An ACIAR-funded rodent project has advanced the knowledge of rodent pest ecology and control in Southeast Asia. This project is building on this large ecological knowledge base.

The project will investigate the technical, social and economic aspects of rodent pest management in Cambodia. The researchers will identify appropriate social institutions for managing the trap barrier system as a common property resource at a village level; evaluate various technological options for improved rodent management in Cambodia, and promote a greater familiarity with, and acceptance by the Cambodian Agricultural Research and Development Institute of community-based approaches to technology development.

Project progress

As at October 2006 the progress report is forthcoming, last years report has been included for information.

Year 5 (01/07/2005–30/06/2005) report

To facilitate the transformation of advances in understanding rodent ecology into development outcomes, ACIAR has funded this project to investigate factors affecting the adoption of the community TBS in Kampong Cham Province in Cambodia. The key findings of this project indicate that the adoption of the technology is limited because the cost of establishing and maintaining the community TBS is justified if rodent damage to crops is high. A community TBS must be implemented in the rice field at the transplanting stage so that a lure crop is planted inside the TBS. However, farmers cannot make a timely decision whether or not to implement a community TBS because it is too early to forecast rodent damage to crops at the transplanting stage. However a number of farmers from project sites with high annual rodent damage have adopted and improved the community TBS.

The financial support from the project (e.g. supply of trap and fence materials) for the community TBS has been gradually phased out from 40% of total cost in 2003 to 0% in 2004. The number of TBS groups, the number of participating farmers, and the quality of TBS construction and maintenance did not decline over this period, indicating that the community TBS is self sustainable.

The most commonly used rodent control method in Southeast Asia has been and will continue to be the application of zinc phosphide bait. This is because the bait has been the most affordable technology for rice farmers. Laying zinc phosphide bait is also the most commonly used method for the control of mouse plagues in Australia. A group of key farmers designed and implemented bait trials to develop improved methods of zinc phosphide baiting. They found that bait uptake and palatability was improved by replacing maize with rice as the bait base. They also learnt to manufacture wax block bait with technical inputs from the project. They prefer to use wax block bait because they are weather resistant and not palatable to non-target species such as chickens, dogs and other domestic animals.

The participating farmers have improved both the TBS and zinc phosphide baiting technologies. They played the role as trainers in workshops to teach other farmers to use these technologies. Although the primary aim of these workshops was to field test the extension material developed by the project, the workshops did achieve extension of the technologies to farmers from nearby communes. However, the success of the extension was limited geographically because only farmers near the project site could attend the workshops. The project was not designed to extend the technologies.

Extension material for community TBS has been developed and used for training workshops and general distribution through the government network. This material is currently being updated because of the continuing improvements made by the participating farmers of the project. Extension material for zinc phosphide baiting technologies is being developed and will be available in by the end of 2005. It has been drafted in Khmer and will be finalised and distributed to researchers and extension workers in Cambodia through the government network by the end of 2005.

SFS/2004/016: A systems approach to rodent management in upland environments in Lao PDR

Overseas Collaborating Countries	Lao PDR
Commissioned Organisation	CSIRO Sustainable Ecosystems, Australia
Project Leader	Mr Peter Brown Phone: 02 6242 1562 Fax: 02 6242 1505 Email: peter.brown@csiro.au
Collaborating Institutions	National Agriculture and Forestry Research Institute, Lao PDR World Vision in Lao PDR, Lao PDR
Project Budget	$215,939
Project Duration	01/01/2005 to 31/12/2006
ACIAR Research Program Manager	Dr Simon Hearn

Project background and objectives

Shifting cultivation remains one of the dominant production systems in many upland areas throughout Southeast Asia. Many of the rural communities practising this traditional agriculture are very poor. In the uplands of Lao PDR this pattern holds true, with smallholders amongst the poorest in Asia. Lao farmers practicing shifting cultivation in upland areas grow rice, maize, sorghum and other crops. Rodent pests are a major production constraint. Farmers cite this as the problem they have the least control over. Past ACIAR research has developed a population-based control, the community trap barrier system (TBS). The TBS uses a lure crop, planted ahead of the main crop and traps strategically placed around a barrier encasing this lure crop, to trap sufficient quantities of rodents to break population cycles, which coincide with crop cycles.

Past project work in Lao PDR introduced the TBS concept, established for lowland irrigated rice, into an upland shifting cultivation setting. Farmers adapted this to protect stored grain but found it had limited impact in the field. Rodent population data, together with data on past rodent outbreaks, were also collected. These will now be used to test rodent management practices amongst farmers.

Existing knowledge, attitudes and practices will be evaluated to help adapt and adopt a rodent management system suitable for upland shifting cultivation settings by:

- developing robust management solutions for rodent management in upland shifting cultivation systems, based on understanding of population dynamics of the key rodent pests and to preparing a manual on rodent control
- determining the sociological and cultural factors that influence farmers' decisions on the adoption of rodent management through conducting pre- and post-survey of knowledge, attitudes and practices in Lao PDR
- developing the capacity and involvement of government and NGO extension for establishing adoption pathways of ecologically-based rodent management

Project progress

Year 1 (01/01/2005–31/12/2005)

This project has made substantial achievements against the key activities and on track to meeting all milestones. Core project sites were identified and established in Luang Namtha (three treated and three untreated sites) and Luang Prabang (two treated and two untreated). Four key farmers were identified in each village to assist with collection of data and implementation of research activities. Additional project sites were established in Oudomxay (one treated and one untreated) and Houaphan (one treated). Furthermore, through the involvement of World Vision, additional sites were established in three Districts in Luang Prabang. In each District, two or three villages were selected where activities were demonstrated and background information collected.

Trapping protocols were established to monitor the breeding activity of the main pests. Monthly samples are collected from key habitats in Luang Namtha and Luang Prabang.

A workshop entitled 'Initial workshop to develop rodent management practices for upland systems of Lao PDR' was held at the Houaykhot Research Station, Luang Prabang, 27–28 April 2005 and was attended by 49 participants, including 19 farmers from two provinces. This was a highly successful workshop because of the strong commitment of the NAFRI staff and the involvement of the farmers. A suite of potential rodent management actions was developed for the lowland, upland and village habitats. This was the basis for rodent control actions for the treated sites in the wet and dry seasons of 2005. NAFRI staff encouraged farmers in the treated sites to conduct these practices. Information on the number of farmers at each site that were participating in these practices was recorded.

A draft manual containing information about the key pests in Lao PDR and an identification key is being developed. This will be finalised shortly and then translated into Lao before being printed and distributed. Additionally, two posters describing the main pest rodent species and the main rodent control actions (identified during the workshop) are being developed.

Information on damage caused by rodents to crops was collected through damage assessment surveys and yield loss 'exclosures' (small areas of crop surrounded by a plastic fence to exclude rats). Damage was low in the wet season in 2005, except at sites in Oudomxay, where damage was approximately 20%.

During selection of project sites, we conducted focus group discussions along with social mapping and wealth analyses. These formed the basis of the background information for each of the sites. We also conducted a knowledge, attitudes and practices (KAP) survey of farmers (15 males, five females) from each site. Preliminary results show that 97% of farmers considered that rodents were their main pest problem, with rice, corn and Job's tear suffering most damage.

A two-day training workshop on rodent biology and management for key staff involved in the project was held in Luang Namtha, 4–5 August 2005, with 15 participants drawn from Provincial and District Agriculture and Forestry Offices from Luang Namtha, Luang Prabang, Oudomxay and Houaphan provinces, in addition to World Vision Lao PDR staff and staff from an EU project in Luang Namtha. The course provided information on the biology and taxonomy of rodents that is important to assist with the management of rodents.

Training courses for farmers were conducted on each of the seven treatment sites and included biology and ecology of the main rodent pest species, control options (including demonstration of techniques), project activities and importance of collecting data from farmers. There were 15-20 farmers involved from each site.

Formal linkages for adoption pathways are being developed. There are strong links with World Vision Lao PDR, and we have had staff involved from an EU project in Luang Namtha. Additional links have been established with various institutions within NAFRI and with Provincial and District Agriculture Offices, particularly in Luang Namtha and Luang Prabang. Staff from these offices attended the workshop in April and the training course in August.

FST/1999/035: The impact of changing agroforestry mosaics on catchment water yield and quality in Southeast Asia

Overseas Collaborating Countries	Indonesia, Thailand
Commissioned Organisation	World Agroforestry Centre, South East Asian Regional Research Program, Indonesia
Project Leader	Dr Meine van Noordwijk Phone: 62 254 1625415 Fax: 62 2541 625416 Email: m.van-noordwijk@cgiar.org
Collaborating Institutions	Bogor Agricultural University, Indonesia CSIRO Land and Water, Australia Chiang Mai University, Thailand Lampung University, Indonesia Forest and Nature Conservation Research and Development Centre, Indonesia Australian National University, Australia Center for Soil and Agroclimate Research, Indonesia Brawijaya University, Indonesia National University of Singapore, Singapore
Project Budget	$1,142,952
Project Duration	01/07/2002 to 30/06/2007 (Project extended from 01/07/2006 to 30/06/2007)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Forest conversion in much of the uplands of Southeast Asia has resulted in a gradual loss of forest functions as the landscapes evolve into mosaics of agriculture, agroforestry and forest remnants. Inappropriate policies have frequently fuelled disputes about use of land for forest or agriculture, leading to unnecessary conflict between upland and lowland farmers. Thousands of poor communities inhabiting upland watersheds are blamed for the destruction of forests and associated hydrological functions that affect communities downstream. This has led to restrictions on land use, and there is little chance of secure land tenure for such communities.

Research is needed to gain greater understanding of the watershed hydrology in these agroforestry landscape mosaics and to use the knowledge to develop more equitable policies and practices for upland farmers. This project will test the hypothesis that some farmer-developed agroforestry mosaics are as effective as the original forest cover in protecting water yield and water quality.

This project will study selected watersheds to characterise current land use and ongoing trends in land-use change, and determine their effects on filter functions and overall impacts on water quantity, seasonal effects and sediment loads. Studies will also test soil and water movement in landscape mosaics at catchment scale; quantify the trade-off between watershed functions and profitability of land use for current and possible future land-use mosaics, and explore alternative practices through farmer participation.

Project progress

Year 4 (01/07/2005–30/06/2006)

In the fourth year of the project we made further progress towards each of the three project goals for the major research sites in Sumberjaya (Lampung, Indonesia) and Mae Chaem (northern Thailand):

Synthesis of the sediment concentration data for Sumberjaya revealed the interplay of multiple factors, but the complex geology of the area dominates over land cover. Surprisingly, concentrations as high as 1606 mg/l were measured where streams leave the forested top of the Bukit Rigis mountain. Frequent small landslides in unstable tuff (derived from the historic Ranau volcanic eruption) material cannot be prevented by the existing forest cover. The western half of the Way Besai catchment is also characterised by outcrops of Ranau tuff, generally more susceptible to erosion, likely contributing to the large sediment loads in rivers like Way Lirikan, Way Ringki, Way Kabul and Air Napalan. The Tangkit Tebak mountain in the east underlying a number of catchments with generally low sediment loads has a more stable lithology and soils with 23–32% (v/v) drainage pores in the top soil layer, in contrast with sils with only 12–13% (v/v) drainage pores and high erodibility elsewhere. The area upstream of one of the cleanest measuring points covers 36% of the catchment area and would rank low on the list of priority catchments for 'watershed rehabilitation'.

Ironically, the past eviction and reforestation efforts were targeted to those headwaters. In hindsight, the evictions and conflict had no rationale in measurable watershed functions. While earlier analyses indicated that available rainfall–discharge data did not allow a good parametrisation of the IHACRES model, significant progress was made in the fourth year. Considerable effort to strengthen the rating curves for three positions in the main river, and better understanding of the backflow problems that reduce the validity of the measurement site on which most previous analyses were based, has led to a tighter fit between data and model. The average water yield per unit area is approximately constant in this new adjusted model, leaving small-range spatial variability of rainfall as key explanation of the lack of fit between model and measurements. Significant progress was made on the participatory assessment of the landscape resources, the sources of sediment loads to the rivers and the opportunities for 'river care'. Schools in the area became involved in the monitoring of water quality though macro-invertebrate indicators. These surveys proved to be important entry points for further community involvement in the watershed.

Earlier analyses focused on the dynamics of the litter layer as the primary filter for overland flow, consistent with the GUEST model. Simulation models thus have to include the dynamics of litterfall, the rates of decomposition and overland transport of litter, in order to adequately describe sediment influx to streams. Coffee gardens generally reach a stable litter layer at 3–5 years of age, and beyond that point most sediment derives from the trails used for motorbike access to the gardens.

After initial problems with calibration, a full year's dataset of sediment on such trails is currently compiled. Current estimates suggest that about half of the sediment in the streams derives from bank instability, with significant differences between trees depending on their rooting characteristics. As a combination of 'soil anchoring' and 'topsoil binding' is desirable, a mixed vegetation is to be preferred. Detailed analysis of riparian vegetation in Mae Chaem now allows a direct comparison between the two catchments in this regard.

The integrative landscape dynamics model, FALLOW, was adapted to the Mae Chaem landscape and will be used for overall comparisons between the Indonesian and Thai watershed. With cofunding from other sources a more direct approach to the opportunity costs of soil conservation in the context of coffee gardens was made, using an auction approach to establish the level of financial rewards necessary before farmers would be able to make the necessary investments. In parallel, farmer groups undertaking a 'river care' commitment build on the joint analysis of 'weak links' in the landscape filters for an outcome-based reward scheme for reducing sediment loads. After a very gradual 'warm-up', the hydroelectricity company showed active interest in these results and discussions on a continuation of their involvement after the end of the ACIAR-supported project are promising. The number of farmer groups with signed agreements for conservation and use of the forest margin increased from five to 23, with significantly reduced transaction costs for the new agreements. A transition from 'proof of principle' to 'proof of application' can now be made. An impact study documents a doubling of farmer assets, a potential income increase of about 30% and enhanced equity for farm households engaged in these contracts, which now cover 70% of the relevant area.

LPS/2004/046: Forage legumes for supplementing village pigs in Lao PDR

Overseas Collaborating Countries	Lao PDR
Commissioned Organisation	International Center for Tropical Agriculture, Lao PDR
Project Leader	Dr Werner Stur Phone: 856 21 770 090 Fax: 856 20 781 0301 Email: w.stur@cgiar.org
Collaborating Institutions	Queensland Department of Primary Industries and Fisheries, Australia International Livestock Research Institute, Lao PDR National Agriculture and Forestry Research Institute, Lao PDR
Project Budget	$399,951
Project Duration	01/01/2006 to 31/12/2008
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

The Lao PDR government has given highest priority in its rural development strategy to improving livestock production systems, given the potential of livestock production to alleviate poverty and reduce shifting cultivation. Rearing pigs is a widespread smallholder livelihood activity in the northern mountainous regions, but productivity is low due to poor nutrition. The introduction of forage legumes into the farming system offers the opportunity to improve pig nutrition and to reduce the time spent by women in gathering and preparing feed. The project will initially document existing pig feeding and production systems to help identify entry points for new practices. It will use the scaling-up of a promising forage, with at least 1000 farmers to learn how they adapt and integrate that feed into their farming systems. It will also introduce and evaluate new forages for their suitability as pig feeds. Broader adoption of these technologies will be achieved through the network of agencies in Lao, the development of guidelines for use by other groups in scaling up this innovation and through pending large development programs that involve CIAT and the Lao partner organisations.

Project progress

First progress report due in 2007.

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

Overseas Collaborating Countries	Philippines, Thailand, Vietnam
Commissioned Organisation	International Rice Research Institute, Philippines
Project Leader	Dr Thelma Paris Phone: (63-2) 845 0563 , 812 7686 , 844 3351 ext 312 Fax: (63-2) 891 1292, 845 0606 Email: t.paris@cgiar.org
Collaborating Institutions	Curtin University of Technology, Australia Khon Kaen University, Thailand Cuu Long Rice Research Institute, Vietnam
Project Budget	$496,764
Project Duration	01/01/2004 to 31/12/2007 (Project extended from 01/07/2007 to 31/12/2007)
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

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

The wider these pressures and their 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/conserve 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.

The progress of the project activities was monitored through two meetings. The first included training on statistical and multivariate analysis; the second included training on data analysis (econometric analysis) of the 800 households surveyed.

Concluded projects

1 July 2005 to 30 June 2006

Bilateral

Multilateral

Bilateral

ASEM/2001/107: Accelerating the impacts of participatory research and extension on shifting cultivation farming systems in Lao PDR

Overseas Collaborating Countries	Lao PDR
Commissioned Organisation	Charles Sturt University, Natural Resource Management and Extension, Australia
Project Leader	Dr Joanne Millar Phone: 02 6051 9859 Fax: 02 6051 9897 Email: jmillar@csu.edu.au
Collaborating Institutions	National Agriculture and Forestry Extension Service, Department of Livestock and Fisheries, Lao PDR International Center for Tropical Agriculture, Department of Livestock and Fisheries, Lao PDR
Project Budget	$394,475
Project Duration	01/07/2003 to 30/06/2006 (Project extended from 01/01/2006 to 30/06/2006)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Upland areas of northern Lao PDR have not benefited from market intensification and diversification in agriculture taking place along the country's Mekong corridor. The majority of the population in these areas live in rural households and villages and are engaged in shifting agricultural cultivation. The poverty gap between those rural householders in the Mekong corridor and those in the upland areas is widening, with upland minorities in danger of being left behind. Poverty in upland areas has increased through a combination of factors, including population increases, poor land allocation policies, resettlement and natural disasters. Crop rotations have shortened and yields have fallen, livestock diseases, pests and weeds are present and upland rice dominates cropping systems. The national average area for rice production is only 31 per cent, but in the northern uplands it is more than 65 per cent. Householders rely on livestock and fish rearing to generate cash income.

Farming systems vary greatly, within and between villages, depending on land tenure and access, soil types and fertility, labour, forest resources, market access, diseases and farming and traditional skills. Creating the means by which farmers become willing to transition to more sustainable agricultural systems is linked to knowledge of the practices to support these systems. Working with farmers in participatory research is an effective way to transfer knowledge and begin transition, as well as offering insights into why farmers make choices to change or remain with traditional approaches.

The overall aim of the project is to determine effective ways to accelerate and spread the impacts of participatory research and farmer innovation as implemented by the FLSP towards more economically and biologically sustainable upland farming systems, through:

- understanding how and why farmers are able to modify their upland farming systems away from a reliance on shifting cultivation through the use and innovation of relevant technologies
- accelerating and spreading impacts resulting from participatory research and extension
- facilitating organisational learning and development towards participatory approaches.

Project progress

Farmer participation and adoption rates were substantially accelerated using a variety of extension methods. These methods stimulated farmer to farmer learning and improved the extension skills of district staff. The FLSP more than doubled the number of villages and households adopting forages and improved livestock management from 54 to 120 villages and 600 to 1400 farmers within two years. An understanding of how and why farmers were adopting forages (with some gaining significant impacts) was developed from case studies and household surveys. Different extension methods were trialled for introducing forages to new villages including case study presentations, cross visits (farmers visiting a village with impacts), and champion farmer visits. A total of 350 farmers were involved in cross visits, study tours and field days from 2003 to 2005. A significant outcome of using all three methods was a 50% reduction in the time required for new farmers to gain impacts from using forages compared to 2001–2003 when original farmers were starting out on their own.

An action research study compared effectiveness of the three extension methods in stimulating early adoption of forages. Cross visits were found to be more effective in enabling farmers to quickly establish and manage their forages than case study presentations or champion farmer visits. Cross visits were also the preferred learning method for most of the farmers interviewed (able to see the technology being used and interact with the host farmers were primary reasons given). However they require greater time commitment and cost for the benefit of fewer farmers, unless farmers are willing and able to act as extension agents in their villages. The project concluded that all three extension methods were useful at different times and situations due to variations in financial cost, ease of implementation and individual farmer capacity to learn, trial, adopt and expand livestock production. The study enabled district staff to reflect on what they were doing and analyse what impact their actions were having on farmer adoption and learning. As a result, staff are now able to plan which extension methods to use for a given district, village or farmer at critical times. Staff also had to learn to minimise negative impacts on champion farmers and villages from over-visitation, a potential outcome of ‘successful adoption’.

Although the net rate of farmer participation and adoption increased, the project found that some households choose not to adopt livestock technologies. Some farmers are unable to participate, other farmers trial forages and then stop, whilst others use livestock production as a stepping stone to change enterprises or get out of farming altogether. A Masters research study found that farmers unable to participate were constrained by their age, limited land and labour, or lack of cash to buy livestock or fencing. Those farmers who chose not to adopt forages had a preference for growing crops, or negative experiences from growing forages. In some cases, farmers simply were not aware of forages or their potential. Hence, the process of adoption is dynamic and needs to be closely monitored to fully understand adoption pathways. Farmer participation in projects and their ability or desire to take advantage of new technologies can also be influenced by many social, environmental and economic factors.

A survey of 30 villages in Xieng Ngeun district in Luang Prabang province determined factors enabling, driving or limiting farming systems change. Major village and institutional factors include remoteness, distance from markets, land allocation, relocation, limited water supply, and lack of technical or market information. Farmers are interested in moving away from shifting cultivation if they can generate enough cash income from cash crops, livestock, forest products and handicrafts. However, rice security is paramount to their concerns along with uncertainty over new crops and markets, livestock diseases and diminishing forest resources.

Initial benefits to upland households from using forages were faster livestock weight gain, healthier animals, reduced labour in finding local feed, closer management of livestock, reduced cost of buying pig feeds, and better prices for fattened animals, all anticipated by the FLSP and ACIAR project. Over time these benefits started to impact on livelihoods and poverty reduction—for example, increased cash income to buy goods and services, and a reduction in reliance on upland rice production as families were able to buy rice. There were some unexpected impacts from labour saving such as children being able to go to school and more time to diversify into other enterprises. A total of 150 households had reduced or stopped shifting cultivation by July 2005.

An increase in staff knowledge, skills, motivation and confidence was evident throughout the project and is now recognised by their district and provincial managers. There is now a common institutional understanding that farmer participation, trialling and adoption can be accelerated using appropriate extension methods at critical times whilst catering for individual household constraints.

CIM/1999/048: Increased productivity of rice-based cropping systems in Lao PDR, Cambodia and Australia

Overseas Collaborating Countries	Cambodia, Lao PDR
Commissioned Organisation	University of Queensland, Department of Agriculture, Australia
Project Leader	Dr Shu Fukai Phone: 07 33652340 Fax: 07 33651188 Email: s.fukai@uq.edu.au
Collaborating Institutions	National Agriculture and Forestry Research Institute, Lao PDR International Rice Research Institute, Philippines Cambodia Agricultural Research and Development Institute, Cambodia CRC for Sustainable Rice Production, Australia
Project Budget	$1,452,142
Project Duration	01/07/2000 to 30/06/2006 (Project extended from 01/07/2005 to 30/06/2006)
ACIAR Research Program Manager	Dr Paul Fox

Project background and objectives

In Lao PDR and Cambodia, rice is the staple foodstuff and also the most important crop economically. The most common rice-growing system in these countries is lowland and rain-fed. Most rice grown in this way is consumed directly by the subsistence farmers who grow it. There are few inputs to the system, and the productivity is low. One crop is grown per year, occurring in the wet season. Poor soil nutrients and periodic droughts are also constraints. There is little doubt that yields could be increased with rice cultivars that are productive even under conditions of reduced water and low soil fertility. Lao PDR and Cambodia are still new at breeding rice and systematic research does not take place.

However, there have recently been changes in the rice cultivars used, with a tendency towards shorter-duration cultivars, planting seed earlier and hence earlier harvesting. This opens the possibility of growing a second crop (of rice or another plant). Another option is the development of direct seeding technologies, which eliminate the need to transplant rice seedlings—a procedure that can result in losses. The disadvantage of direct seeding is that weeds compete with the rice. The project examined planting methods, direct seeding and the development of suitable cultivars for use in the two countries. In Australia, the problems are different, and cultivars are required that can grow well during the early part of the season when it is cooler. This issue was also examined, and suitable cultivars could be of benefit to areas of northern Lao PDR.

The project focused on improving rice-breeding and agronomic techniques so as to increase productivity and improving stability mainly in lowland rice-based cropping systems in Lao PDR and Cambodia. This included the development of agro-ecological maps in Lao PDR to assist the evaluation of the potential of cropping systems strategies and the development of seedling techniques to overcome effects of low temperature at planting.

Project outcomes

Rainfed lowland rice breeding
One objective of the project was to incorporate selection for drought tolerance into the rice breeding program in order to develop new varieties more resilient to drought. The project was successful in developing a method for reliable and routine screening of relatively large numbers of lines for drought tolerance and for crossing the best drought tolerant lines with high quality and high potential yields to generate new lines that are resilient to drought and yet yield well in good years and have quality characters desired by the farmers. The project tested these lines widely across the rainfed conditions. The result for the genotype by environment interactions indicate that testing over six locations and for two years is required to identify improved varieties for the rainfed lowlands. These new breeding approaches have been incorporated into the breeding programmes in Lao PDR and Cambodia. In addition Lao rice breeders have also been trained to properly document, electronically, the pedigree of the breeding program as a basis for improved efficiency and breeding progress. The methods for breeding for drought tolerance have been incorporated into a manual for drought breeding for rice. The manual "Breeding Rice for Drought-Prone Environments" is published by IRRI and available on line at http://www.knowledgebank.irri.org/drought/drought.pdf

Direct seeding technology
Increasingly labour is becoming costly and unavailable for transplanting rice. In Lao PDR, the project developed direct seeding technology to replace transplanting, particularly in dry-season irrigated rice. Farmers in the Vientiane Plains now use the technology. However in the wet season the technique should be used only in limited areas where weeds are not the main problem and drainage is good.

In Cambodia, the project examined the varietal requirement for direct seeding systems. Evaluation of a large number of cultivars under both direct seeding and transplanting showed that the new breeding program can produce cultivars for both transplanting and direct seeding and thus maintain maximum flexibility in cultivar choice for farmers. Under favourable conditions and with good weed control, yield from direct seeding was often slightly higher than the crop established from transplanting.

Cropping intensification
The possibility of intensifying the cropping cycle in rainfed lowlands in Cambodia was examined by double cropping of rice, and by rice–mungbean double cropping in early wet season and wet season. The results of 16 experiments over 5 years, farmers interviews and economic analysis indicate that rice–rice double cropping is a feasible option for the more favourable part of the rainfed lowland, particularly where supplementary irrigation is available.

In central and southern Lao PDR double cropping of rice is possible in most lowland areas where irrigation water is available in the dry season. Earlier maturing rice varieties are needed for use in the first planting of the rice–rice system.

Dry season irrigated rice in northern Lao PDR
Intensification of rice is difficult in the high altitude areas in northern Lao PDR (altitude greater than 500 m) where low temperature (monthly minimum temperature below 12^0C) can damage rice establishment. The project determined that a second rice crop must be sown in November before the onset of the colder conditions. Early maturing varieties were developed to facilitate the planting of a second crop in this window.

However often irrigation water is not available for the crop to be established in November to avoid cold temperature damage. Project developed a simple nursery system to protect the young plants from the cold temperatures, using locally available plastics. Collaborators who have tested this technique have achieved 20% higher yield compared with the yield of crop that was established from the conventional unprotected nursery in mid-winter.

Agro-ecological characterisation and mapping of environment
The project developed a number of agro-ecological maps for Lao PDR to define cropping zones, based on GIS and using information on temperature (available in CD), rainfall and potential evapotranspiration to define cropping patterns such as the period of wet season, identification of hot months for any locations in Lao PDR. These maps have been used to identify areas where rice sowing in December is risky due to frequent occurrence of low temperature and thus the target areas for nursery protection. Water availability in rice paddies is complicated because of downward and lateral water movement; the project quantified these components for better estimation of paddy water environments for mapping. These maps are of potential use by decision makers in planning and targeting research for Lao PDR.

Reducing cold temperature damage to rice in Australia
The project compared rice genotypes for their susceptibility to pre-flowering low temperature and also studied the effect of N nutrition on damage. A screening method for identifying cold tolerance was developed and a number of cold tolerant varieties were identified.

FIS/2000/061: Development and delivery of practical disease control programs for small-scale shrimp farmers in Indonesia, Thailand and Australia

Overseas Collaborating Countries	Indonesia, Thailand
Commissioned Organisation	NSW Department of Primary Industries, Australia
Project Leader	Dr Dick Callinan Phone: 02 6688 6289 (home) Fax: 02 6626 1276 Email: richardcallinan@versa.com.au
Collaborating Institutions	Directorate General of Fisheries, Indonesia Network of Aquaculture Centres in Asia Pacific, Thailand Asian Institute of Technology, Thailand James Cook University, Australia Queensland Department of Primary Industries and Fisheries, Australia Aquatic Animal Health Research Institute, Thailand Department of Fisheries, Western Australia, Australia
Project Budget	$1,114,202
Project Duration	01/07/2001 to 31/03/2006 (Project extended from 01/07/2005 to 31/03/2006)
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

The world production of farm shrimp in 1996 was valued at over $10 billion. About 80 per cent of the crop is produced in Asia, largely by small-scale farmers. In Thailand, 90 per cent of shrimp farms are smaller than 1.6 ha, while in Indonesia almost 50 per cent are less than 2 ha. In Australia, the bulk of producers are also small farmers that operate on average on 15 ha of ponds. *Penaeus monodon* is the most important farmed shrimp species in Southeast Asia and Australia. Infectious diseases are consistently identified as the major threat to the long-term viability of the shrimp farming industry in the Asia-Pacific region, and recurrent massive outbreaks of viral diseases have caused serious financial losses among smallholders.

To address this situation, researchers have worked towards developing effective farm-level, shrimp disease-control programs. This work has now produced relevant expertise and information, but because of lack of definitive, on-farm program validations and inadequacies in the delivery of extension programs, smallholders have generally failed to benefit.

The main aim of this project was for farmers, scientists and extension workers in Indonesia, Thailand, and Australia to acquire the necessary knowledge, practical skills and willingness to implement, retain and continue publicising the shrimp disease-control programs that have been developed for small-scale shrimp farms. Additionally, the project aimed to support an existing shrimp disease and coastal management study in India.

Project progress

This four-year project had two linked components, a ‘core’ project component in Indonesia, Thailand and Australia, for which ACIAR was the sole external funding provider and a ‘collaborative’ project component in India, with NACA and MPEDA, for which ACIAR provided supplementary funding. The first component is described here.

Completion of training, in practical disease control issues, for nucleus groups of progressive Indonesian farmers, health management technicians and disease diagnosticians
Project staff and those in related agencies undertook significant training in laboratory techniques and extension processes. This was supported by additional funding for workshops based on identified needs. Farmer training was delivered at selected sites in East Java and South Sulawesi via meetings based around farmer groups, focusing on demonstration ponds operated by key lead farmers.

Description of pathology and epidemiology of diseases causing significant production loss on Australian shrimp farms, with particular attention to diseases associated with GAV and SMV infections.
Project staff made important progress in understanding the epidemiology of GAV-associated disease outbreaks on Australian farms. On the three representative farms studied, infection prevalence and GAV load were associated with disease severity. A number of papers describing these findings are in preparation and results have been incorporated into the comprehensive best-practice manual for Australian farmers produced by project staff (see below). In addition, new low-cost technology, such as a pond side ELISA test, has also been developed, with potential to benefit Australian and Asian farmers. SMV infection was considered of relatively minor importance and was not further addressed during the project.

Development of appropriate, country-specific extension processes for smallholder shrimp farmers in Indonesia, Thailand and Australia
Detailed preparatory work was undertaken in mapping out information and knowledge systems, and planning the most effective extension processes for each social and cultural context. In working with key farmers and farmer groups, project staff then used carefully selected participative and learning approaches. Numerous targeted extension products were developed, consistent with reaching identified stakeholder groups. A comprehensive prawn farming manual, specifically for Australian farmers and incorporating best practice health management principles, was produced in collaboration with APFA and widely distributed.

Validation of farm-level disease control programs for smallholder shrimp farmers in Indonesia, Thailand and Australia
In Indonesia and Thailand, best management practices were validated for smallholder semi-intensive farmers (Indonesia) and intensive farmers (Thailand) in most target districts and significant gains made in crop 'success' by the measures used. Attempts at validation in South Sulawesi were unsuccessful; potential reasons included soils factors and close proximity of diseased, non-participant farms. Interventions to reduce GAV-related losses were presented in the project-produced manual provided to Australian farmers.

Demonstration of validated disease control programs on selected smallholder farms in Indonesia and Thailand.
Despite an initial disease-related setback at a demonstration site in Indonesia and a major shift in species farmed in Thailand, validated programs were used for demonstration and learning purposes amongst participating farmer groups, neighbouring and visiting farmers at various levels. There were varying levels of 'success' in bringing other farmers on board. Factors inhibiting some smallholder farmers from adopting best-practice approaches included: access to credit/resources (Indonesia); low prices and need for a premium price (Thailand). An unexpected, enthusiastic adoption of modified programs amongst non-target ‘extensive’ farmers in areas occurred near demonstration sites in Java, perhaps because implementation amongst this group does not require significant additional investment.

Extension of validated disease control programs to smallholder shrimp farmers in Indonesia, Thailand and Australia.

Development of carefully targeted extension approaches was a key activity within the project. Consequently, there was generally good adoption within farmer groups linked to successful demonstration ponds and this led to significant production improvements. The use of socio-grams and continuous reflection and improvement processes informed the extension activities. Impact assessment was undertaken in Indonesia and Thailand. Initial results indicate strong diffusion rates from participating farmers and significant gains with farmers who adopted recommendations in most cases. Carefully targeted extension materials have been developed and these have been widely circulated at varying levels to key stakeholders including relevant extension staff and the private sector. The lack of effective government extension systems in aquaculture is one of the limitations to wider integration of technologies. Some steps have been taken to work with the private sector (feed and seed suppliers) with potential for further development.

FIS/2005/027: Regional workshop on low value and trash fish in the Asia-Pacific region

Overseas Collaborating Countries	Thailand
Commissioned Organisation	Asian Institute of Technology, Thailand
Project Leader	Professor Peter Edwards
Collaborating Institutions	
Project Budget	$6,230
Project Duration	19/05/2005 to 05/09/2005
ACIAR Research Program Manager	Dr Geoff Allan

Project background and objectives

Low value or so-called 'trash fish' is a broad term used for fish species that by virtue of their small size or low consumer preference have little or no commercial value. A large number of small-scale fisheries in the Asia Pacific Region generate a substantial quantity of 'trash fish'. These fish may be consumed or utilised as part of household food, locally processed or used for small-scale rural aquaculture and livestock raising. This workshop aims to develop a clearer regional understanding of the status of 'trash fish' production. This may be achieved by carrying out discussions around the quantity of trash fish in the region and the current trends occurring.

Project outcomes

This workshop provided a forum for discussion about the regional problem of better utilising trash fish and conserving fish stocks.

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	Lao PDR, 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 is to disseminate and share experiences gained through ACIAR projects relating to culturing fish in inland reservoirs. This will be achieved through a series of workshops with local fish farmers, aquaculture planners and developers in Bangladesh, Lao PDR 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.

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 that are 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; and
6) to decontaminate the field sites heavily affected with metal salts, especially cadmium, and to dispose of the contaminated soil using internationally accepted methods.

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
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Collaborating Institutions	Griffith University, Australia Department of Agriculture, Thailand Institute of Agricultural Genetics, Vietnam University of the Philippines at Los Banõs, 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 are 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 progress

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 regulars 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 acclimatisation 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

at 30 June 2006

Bilateral

ADP/2006/170	Quarantine and trade policy in Thailand
AH/2003/008	Enhancing beef production in Cambodia through better nutrition
AH/2005/084	Improved supply and quality of livestock vaccines in Lao PDR
AH/2005/086	Best practice control of diseases in cattle, Lao PDR and Cambodia
AH/2006/025	Improved risk assessment for transboundary disease in Lao PDR and Cambodia
AH/2006/077	Identifying research priorities for the development of the beef industry in Cambodia and Lao PDR with special reference to animal health interventions
AH/2006/097	Diagnosis and epidemiology of foot and mouth disease in Lao PDR 1997-2006
AH/2006/155	Vaccine business development in Lao PDR
AH/2006/159	Cattle health in Lao PDR
AH/2006/160	Disease risk in Lao PDR
AH/2006/161	Zoonosis in pigs in Lao PDR
ASEM/2005/124	Extension approaches to scaling out livestock production in northern Lao PDR
ASEM/2006/060	Lao Agricultural Research Fund (LARF)
ASEM/2006/130	Enhancing adoption of new farming systems in Cambodia and Australia
CIM/2006/040	Crop diversification in lowland rice cropping areas in Cambodia
CIM/2006/041	Crop intensification and yield improvement in lowland rice cropping areas in Lao PDR
FIS/2005/078	Culture-based fisheries development in Lao PDR
FIS/2006/137	Analysis of the Dai fishery Lao PDR
FST/2004/057	Optimising production of timber and non-timber forest products in Lao PDR agroforestry systems
FST/2005/100	Value adding to Lao PDR plantation timber products
HORT/2006/107	Post harvest vegetables in Cambodia

Multilateral

PLIA/2003/063	Increasing the effective use of livestock research for development in SE Asia

ACIAR publications

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

Impact Assessment Series

1 Control of Newcastle disease in village chickens
5 Fruit fly in Malaysia and Thailand 1985–1993
6 Pigeonpea improvement
7 Reducing fish losses due to epizootic ulcerative syndrome
9 Sulphur test KCl-40 and growth of the Australian canola industry
11 Postharvest R&D concerning tropical fruits
14 Improved drying of high moisture grains
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 Southeast Asia
23 Improved methods for the diagnosis and control of bluetongue in small ruminants in Asia and the epidemiology and control of bovine ephemeral fever in China
31 Review of ACIAR's research on agricultural policy
35 Review of the returns to ACIAR's bilateral R&D investments
38 Future directions for ACIAR's animal health research
39 Benefits to Australia from ACIAR-funded research
41 ACIAR and public funding of R&D: submission to the productivity commission study on public support for science and innovation
42 Benefits to Australia of selected CABI products

Monographs

2 Nutritional disorders of grain sorghum
5 Newcastle disease in poultry: a new food pellet vaccine
7 Malignant catarrhal fever in Asian livestock
11 Methods for evaluating nitrogen fixation by nodulated legumes in the field
13 Management of acid soils in the humid tropics of Asia
21 The major arthropod pests and weeds of agriculture in Southeast Asia
26 Biological control of weeds: Southeast Asian prospects
30 A profit in our own country
31 Nutrient disorders in plantation eucalypts
32 Working with mycorrhizas in forestry and agriculture
34 Breeding for resistance to infectious diseases in small ruminants
36 Ruminant nutrition and production in the tropics and subtropics
37 Detection and treatment of mineral nutrition problems in grazing sheep
40 Essential oils of tropical *Asteromyrtus*, *Callistemon* and *Melaleuca* species
45 Report on ACIAR-funded research on viroids and viruses of coconut palm and other tropical monocotyledons 1985–1993
48 Nutrient disorders of sweet potato
51 Biological control of insect pests: Southeast Asian prospects
53 Field experiments with forages
58 Understanding animal health in Southeast Asia: advances in collection, management and use of animal health information
97 Effects of globalisation and economic development on the Asian livestock sector
98 Domestication of *Chukrasia**
99 Developing agricultural solutions with smallholder farmers: how to get started with participatory approaches
100 Field methods for rodent studies in Asia and the Indo-Pacific
111 High-yielding anthracnose-resistant *Stylosanthes* for agricultural systems
113 Worm control for small ruminants in tropical Asia
114 Diversity and management of *Phytophthora* in Southeast Asia
118 Integrating knowledge for river basin management—progress in northern Thailand

119 Guidelines for surveillance for plant pests in Asia and the Pacific
120 Better-practice approaches for culture-based fisheries development in Asia
121 Planters and their components: types, attributes, functional requirements, classification and description

Proceedings

13 Bacterial wilt disease in Asia and the South Pacific
18 Food legume improvement for Asian farming systems
29 Sulfur fertiliser policy for lowland and upland cropping systems in Indonesia
33 Sustainable agriculture on marginal uplands of Southeast Asia
42 Productive use of saline lands
50 Postharvest handling of tropical fruit
51 Foot-and-mouth disease in Southeast Asia
57 *Leucaena*—opportunities and limitations
61 Agricultural impacts on groundwater quality
77 Breeding strategies for rainfed lowland rice in drought-prone environments
81 Disease control and storage life extension of fruit
87 Upland farming systems in the Lao PDR: problems and opportunities for livestock
90 Towards sustainable shrimp culture in Thailand and the region
94 Classical swine fever and emerging diseases in Southeast Asia
97 *Hypsipyla* shoot borers in Meliaceae
98 Reservoir and culture-based fisheries: biology and management
101 Increased lowland rice production in the Mekong region
104 Agrochemical pollution of water resources
108 Development strategies for genetic evaluation for beef production in developing countries
111 Eucalypts in Asia
114 Modelling nutrient management in tropical cropping systems
116 Water in agriculture
119 Agriproduct supply chain management in developing countries
121 Evaluation and performance of permanent raised bed cropping systems in Asia, Australia and Mexico
124 Heart rot and root rot in tropical *Acacia* plantations

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16 Mineral nutrition of food legumes in Thailand
30 A review of the biology and management of rodent pests in Southeast Asia
31 *Styrax tonkinesis*: taxonomy, ecology, silviculture and uses
47 Coastal shrimp aquaculture in Thailand: key issues for research
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*
59 Using seasonal climate forecasting in agriculture: a participatory decision-making approach
61 Production technologies for low-chill temperate fruit

Working Papers

25 A preliminary evaluation of 54 ACIAR-supported projects in Thailand (1983–1995)
38 Impact assessment of forty-nine Thailand/Australia collaborative projects funded by ACIAR during 1983–1995
41 Developing forage technologies with smallholder farmers: how to monitor and evaluate impacts
53 Priorities for pig research in Southeast Asia and the Pacific to 2010
54 Mud crab aquaculture in Australia and Southeast Asia
56 Agricultural research and poverty alleviation: some international perspectives
58 Scaling out impacts: a study of three methods for introducing forage technologies to villages in Lao PDR
60 Economics and marketing of the live reef fish trade in Asia-Pacific