Country Profile

Cambodia, Laos and Thailand

November 2004

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, Laos and Thailand that were active at 30 June 2004. At that time there were 23 active bilateral projects and three active multilateral projects, the latter being led by an international agricultural research centre. There were another 12 bilateral projects under development, many of which are expected to start in 2004–05.

This publication also sets out the key outputs and outcomes from 11 bilateral and two multilateral projects that have been completed since July 2002.

In addition to these project summaries, the publication includes an extract from ACIAR's 2003-04 Annual Report covering Cambodia, Laos and Thailand, our near-term program as outlined in the 2004–05 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 will update this profile each year and distribute them to key stakeholders in Cambodia, Laos, 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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November 2004

Cambodian Report 2003–04

(extract from ACIAR Annual Report 2003–04)

Active projects in 2003–04	9
AOP budgeted expenditure in 2003–04	$1,098,618
Actual bilateral country expenditure in 2003–04	$997,832
Bilateral country expenditure in 2002–03	$721,584
Bilateral country expenditure in 2001–02	$489,597

Key performance indicators	Performance 2003–04
Growth in proportion of budget for Cambodia compared with 2002–03.	Expenditure grew from 2.5 per cent to 3.9 per cent.
Extension activities from ACIAR projects conducted jointly with AusAID's Cambodia−Australia Agricultural Extension Project (CAAEP2).	Two projects developed links and worked to support the CAAEP2 project, including undertaking joint activities at field sites in two provinces.
Agricultural diversification activities of three ACIAR Cambodia projects coordinated to allow information flow between project teams.	Coordination between three projects aimed at diversifying agricultural activities regularly undertaken. An additional project is now also involved in the communication network.

Position

Cambodia is of growing importance as a partner country, although Australia has provided significant development assistance in recent years. A major component of AusAID assistance in Cambodia continues to be in agriculture, and ACIAR has taken the opportunity to link several of its research projects to AusAID-supported extension, industry development and institutional capacity-building initiatives. Cambodian farming is largely based on rain-fed rice systems of relatively low productivity. Projects target improvement in rice production as well as agricultural diversification, and expansion of the country's animal health research and development capacity. Cambodia has made good recent progress in developing a group of internationally trained researchers and restoring infrastructure, with ACIAR continuing to offer scientific capacity-building opportunities through its projects.

Achievements

Adapting ACIAR-supported research on rodent management in Southeast Asia to the specific needs of Cambodian farming systems **has led to successful interactions** between farmers, researchers and extension workers. Farmers in selected villages are the main research target and many have already adopted the Trap Barrier System to control rats. Significant benefits in increased yields, reduced losses from rodents and reduction in the use of rodenticides have all been recorded. The project has also delivered social and economic benefits, increasing community interactions to manage rodents and improving livelihoods through more rice. Another research site has been selected to further extend these encouraging results.

Following a successful project to control fasciolosis (a parasitic disease of livestock) a new ACIAR-supported project is updating risk models. Using geographic information systems project scientists are gathering data that together with the earlier knowledge gained from ACIAR research **will form a package that extension officers can use** for the implementation of a national strategy to control fasciolosis. The new project has started to

quantify benefits and costs of control of fasciolosis for farmers. Significant benefits are anticipated, based on results of previous research, through improved income flowing from better growth rates and draught and reproductive performance of cattle and buffaloes, as a result of achieving fasciolosis control.

Selecting rice cultivars suited to Cambodian conditions, where drought is common, continues through a process of drought simulation. Standing water is drained from crops to simulate water stress, allowing researchers to identify cultivars that mature early or adapt well to the effects of drought. This knowledge is now being utilised to develop rice varieties based on early maturity. Double cropping systems significantly **boost rice production** but there are some limitations to the practice. These have been identified and new methods such as earlier planting of rotation crops immediately after rice harvesting and the use of supplementary strategic irrigation will help to improve crop management.

Crop diversification, from rice (where Cambodia has reached self-sufficiency) to other higher value crops has the potential to alleviate rural poverty, but is hampered by a lack of knowledge of how to grow non-rice crops, including choice of suitable land for planting. ACIAR is supporting research to help Cambodia establish viable cropping industries beyond rice. Three study sites representing a range of agro-ecological conditions have been chosen, with detailed soil profile descriptions recorded. Also trial crops sown to establish baseline yield data have demonstrated the need to acquire well suited cultivars. This information will be fed into other related projects.

Scientific capacity in Cambodia continues to grow through the AusAID-funded Cambodian Agricultural Research and Development Institute Assistance Project. The country's scientific capacity diminished greatly during the past two decades, limiting the ability of scientists to deliver effective research. ACIAR is managing a component of the project, **the Cambodian Agricultural Research Fund**, which helps provide the basis of a competitive research sector by support of research projects through a competitive funding scheme. Successful applicants receive training to undertake the research problem identification, preparation of proposals and report writing necessary to interact with the international scientific community and donors.

Cambodian Plan 2004–05

(extract from ACIAR Annual Operational Plan 2004–05)

Population	12.5 million
GNI per capita	AUD 516

Cambodia: Bilateral research expenditure	$m 2002-03 actual	$m 2003-04 budget	$m 2004-05 budget	$m 2005-06 indicative
Active projects	0.65	1.10	0.87	0.5
Committed funds for new projects			0.56	0.7
Projects under design			0.14	0.3
Available for new projects				0.1-0.3
Total*	**0.65**	**1.10**	**1.58**	**1.6-1.8**

*Includes AusAID funds as follows: $0.16m (2002-03 actual), $0.20m (2003-04 budget), $0.23m (2004-05 budget) and $0.2m (2005-06 indicative).

Strategy

ACIAR's strategy in Cambodia is to support research interventions to underpin agricultural diversification while at the same time supporting research that aims to increase the productivity of rice-based farming systems. 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.

Key performance indicators

- Growth in proportion of budget for Cambodia compared with 2003-04, and involvement of new collaborating institutions
- Evidence of assistance in developing the capacity of the Cambodian Agricultural Research and Development Institute to carry out research on crop diversification
- Design and commencement of projects addressing horticulture and livestock production
- Evidence of capacity building in research project design and management of project leaders in Cambodian Agricultural Research Fund projects
- Appropriate linkages with AusAID Cambodia projects and provincial groups in extension of appropriate technologies from ACIAR projects

Position

Cambodia is a relatively new partner country for ACIAR. 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 ACIAR has taken the opportunity to link several of its research projects to AusAID-supported extension, industry development and institutional capacity-building initiatives.

Cambodia has a very low per capita GDP and the predominance of low-productivity rice-based farming soils means that Cambodia has rather low agricultural productivity on both a labour and land area basis. Cambodian farming is largely based on rice systems of relatively low productivity. The suite of current, pipeline and completed projects is correspondingly

targeted at related areas of research, such as improving rice productivity, assessing land suitability for a second rice crop and developing options for production of non-rice crops.

However there has been good recent progress in developing a group of internationally trained researchers along with training and infrastructure provided by other donors – this need and capacity make it an important focus for ACIAR assistance.

ACIAR has also played a role in developing animal health research capacity in Cambodia and will continue to support selected initiatives in animal health and production as well as fisheries.

Indicative priorities

Priorities for ACIAR-Cambodia cooperation have so far been established through visits of research program managers and other senior staff, in meetings with leading agricultural R&D institutions and government bodies.

The following priority areas for collaboration have been determined:

- Improving the productivity of rice-based farming systems through better agronomy and management of pests and diseases, and development of suitable rotation crops
- Technologies to support crop diversification (non-rice crops, soil management, assessment of land suitability for different crops)
- Market chain analysis of non-rice crops
- Improving the efficiency of production and postharvest systems for fruits and vegetables
- Improved livestock health management, and broadening feed and forage supplies for livestock nutrition
- Year-round availability of fish through strengthening aquaculture
- Short-course training in R&D priority-setting and management, in scientific proposal and report writing in English, and in experimental design and analysis

Key program managers

Dr Ken Menz, Agricultural Systems Economics and Management
Dr John Copland, Animal Sciences 1 (animal health)
Dr Colin Piggin, Crop Improvement and Management
Dr Ian Willett, Land and Water Resources
Dr Greg Johnson, Postharvest Technology

Country Manager

Ms Chiraporn Sunpakit, ACIAR Country Manager, Cambodia, Laos and Thailand

Laos Report 2003–04

(extract from ACIAR Annual Report 2003–04)

Active projects in 2003–04	10
AOP budgeted expenditure in 2003–04	$759,205
Actual bilateral country expenditure in 2003–04	$714,519
Bilateral country expenditure in 2002–03	$545,329
Bilateral country expenditure in 2001–02	$613,852

Key performance indicators	Performance 2003–04
Practical assessment tools and management strategies developed for assessing subsurface salinity.	A conceptual salinity assessment model of tools and measurements through bores developed.
Identification of most suitable rice varieties for cooler districts of Laos.	Good data obtained on the success of planting particular rice varieties through links to climatic data.
Development of a new animal health research project linked with major donor initiatives.	A new project on the control of FMD and CSF at the village level has started, with support from the European Union.
Understanding of rodent taxonomy in upland rice.	A working taxonomy guide has been compiled and a guide on field methods for rodent identification published.

Position

ACIAR has had a small, targeted program in Laos operating since 1992, focusing on multi-country projects with Lao components that address special research needs and capacity-building. Projects are designed to complement major donor programs on crops, animal health, forages and forestry, with an emphasis on major policy and technical interactions.

Achievements

Pasture production on marginal lands is threatened by salinity and waterlogging. Lucerne is a deep-rooted perennial plant that helps arrest soil problems and maintain productivity, and **more than 200 lines of lucerne germplasm** have been sourced for testing in Laos, China and Australia. Training has also been provided for a Lao lucerne breeder, providing exposure to the latest breeding techniques.

The productivity of rice-based cropping systems is being increased by the use of temperature and rainfall maps, combined with trials of different sowing times to determine optimum sowing seasons. This includes for double-cropping of rice in irrigated conditions to avoid low temperature exposure.

Trials of many rice varieties across a range of agro-ecological conditions demonstrated that yields could be substantially boosted by **matching of varieties to conditions**. High-yielding lines were identified. Screening varieties for drought tolerance has determined suitable varieties for further breeding. An improved management system for rice nurseries for irrigated rice in northern Laos was also developed.

Research to further the development of a low-chill temperate fruit industry in Laos, Thailand and Vietnam continues. **Locally derived germplasm with disease resistance** (including resistance to some major leaf diseases) **and good quality characteristics** has been

identified for possible incorporation into breeding programs in Laos and Vietnam. Non-astringent persimmons have also been identified as a potential new commercial crop for Laos and the other two countries. Key management practices, including how to control some pests and diseases, have been developed and refined and are now in use. Training to extend this knowledge was also conducted. The need for short-term cash crops while trees mature, to supplement income between seasons, is also being addressed. Based on an external review the project is being extended to refine and extend the production technologies developed and to encourage farmer uptake.

Awareness of the problems of salinity in Laos and northern Thailand continues to be raised through ACIAR-supported research. Monitoring of salinity, through surveys of groundwater levels and water movement, meteorological studies, collection of river discharges and other mechanisms, is producing a clearer picture of the extent of salinity. Maps of saline areas have been produced and **data on tree clearing** and regional geology compiled for the development of hydrogeological models and a salinity database. The maps and database are now helping inform government decision-makers on how to manage salinity.

The ability of the animal health services to manage foot and mouth disease and classical swine fever (CSF), already enhanced by past ACIAR-supported research that **established diagnostic and investigative capabilities for both diseases**, is being further strengthened. A new project is developing improved methodologies to deliver and evaluate village-based vaccination and control of CSF, together with the development of a rapid diagnostic test to support this initiative. Epidemiological information on both diseases is being collected to facilitate control strategies.

A recently commenced project is examining stock structures of two species of Mekong carp, **important for food security in the Mekong** River Basin (where fisheries help feed up to 60 million people across several countries). Managing fish stock is vital as development increases throughout the Basin and encroaches on the river. Laos, Cambodia, Thailand and Vietnam are all involved in the project.

Laos Plan 2004–05

(extract from ACIAR Annual Operational Plan 2004–05)

Population	5.5 million
GNI per capita	AUD 571

Laos: Bilateral research expenditure	$m 2002-03 actual	$m 2003-04 budget	$m 2004-05 budget	$m 2005-06 indicative
Active projects	0.55	0.76	0.45	0.2
Committed funds for new projects			0.33	0.2
Projects under design			0.14	0.2
Available for new projects				0.1-0.3
Total	**0.55**	**0.76**	**0.91**	**0.7-0.9**

Strategy

ACIAR has a small program in Laos which focuses on major policy and technical issues concerning shifting cultivation, livestock health, crop production, and forest production. The diversification of rice-based farming systems in both lowland and upland areas into other cropping, livestock and fisheries enterprises is receiving increasing attention. Research interventions are designed to complement major donor programs on improving rice production (IRRI-Swiss), forages (CIAT-AusAID), forestry (Germany) and animal health (European Union).

Key performance indicators

- Through consultation with Lao PDR partners and international donors, develop a new strategy for ACIAR's investment in Laos for the 2005–2008 period
- Capacity development of the National Agricultural and Forestry Extension Service (NAFES) through involvement in projects and training activities
- Evidence of farmer uptake of new rice varieties and fertiliser systems in central Laos
- Better vaccine delivery systems for Classical Swine Fever for improving pig production for rural communities

Position

ACIAR has had a program in Laos since 1992, coinciding with the period of expansion of Australia's aid program to the Mekong countries.

ACIAR has been commended for the establishment in Vientiane of an animal diseases laboratory to service Laos. Other successes include the introduction and selection of cold- and drought-tolerant rice varieties, management of rodent pests in rice farming, capacity building in forestry research, a study of the management of indigenous fisheries of the Mekong and provision of training, including in scientific data analysis and scientific writing in English.

During 2004–05, ACIAR intends to develop two to three additional projects to increase the size of the Laos program.

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. Research and development will be focused on:

- technical and policy interventions in upland areas, to improve the profitability of low-input farming as an alternative to shifting cultivation
- improved productivity of the dominant rice-based farming systems and diversification to include other crops, livestock and fishery enterprises
- animal health and quarantine, especially related to the critical geographic location of Laos as a livestock transit point
- support to underpin salinity risk assessment in relation to new irrigation developments
- reforestation and sustainable plantation forestry, including through improved forest germplasm
- enhancing the impact of earlier ACIAR project investments at the farmer level

Key program managers

Dr Ken Menz, Agricultural Systems Economics and Management
Dr John Copland, Animal Sciences 1 (animal health)
Dr Colin Piggin, Crop Improvement and Management
Dr John Fryer, Forestry

Country Manager

Ms Chiraporn Sunpakit, ACIAR Country Manager Cambodia, Laos and Thailand

Thailand Report 2003–04

(extract from ACIAR Annual Report 2003–04)

Active projects in 2003–04	23
AOP budgeted expenditure in 2003–04	$1,125,711
Actual bilateral country expenditure in 2003–04	$1,102,630
Bilateral country expenditure in 2002–03	$1,090,643
Bilateral country expenditure in 2001–02	$1,148,593

Key performance indicators	Performance 2003–04
All new projects under development are focusing on implementation of results of earlier ACIAR projects.	All pipeline bilateral projects emphasise implementation of earlier projects. A pipeline multilateral project is regional, with some research applicable in Thailand.
Farmer groups in two provinces establishing fish farming based on manufacture of low-cost feeds using local ingredients.	An external review of an ACIAR–World Vision project visited four low-cost-feed producing centres supporting over 550 families.
Establishment of the OIE Regional foot-and-mouth disease (FMD) laboratory using diagnostic tests developed by ACIAR projects.	The Regional FMD laboratory in Thailand has passed all biosecurity checks and is now receiving diagnostic specimens from other countries and using ACIAR-developed diagnostic tests.

Position

Thailand's research capacity has increased with the country's economic development over the past two decades. As a result its need for ACIAR projects has diminished. ACIAR's investment in projects has decreased 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, particularly neighbouring Mekong countries, from drawing on the development experiences of Thailand. Project investment with Thailand is highly selective, focusing only on implementation of the results of earlier ACIAR projects, with emphasis on delivering these benefits to poor farmers and rural areas.

Achievements

Thailand's **accession to the World Trade Organisation** has demanded new sanitary and phytosanitary measures for its produce. A project under way in Thailand and India is examining existing mechanisms to manage risks. Trends in food exports have been mapped and case studies of organisations in selected food industries undertaken. More than 40 organisations in both countries have been involved to date. The results will be fed back to governments in each country to help shape policy recommendations for improvements to current procedures.

Increased agricultural productivity has resulted in a loss of vegetation cover, necessitating improved water resource management. Integrated Water Resources Assessment and Management **models have been devised and tested** across a range of catchments. Hydrology, erosion, crop and economic models have also been developed, with Thai capacity in this area growing substantially.

Careful management is needed for the water catchments downstream from former forest areas that have been settled and are now being farmed. Current land-use trends and

changes in selected catchments have been characterised, and impacts on water yields and soil properties determined. A database on the impacts on salinity of water use by trees is being compiled for Thailand and Australia. Socioeconomic and cultural surveys have been undertaken **for incorporation into a salinity model**. A risk assessment map of soil acidification has also been developed to predict pH levels for future years, based on accumulated knowledge. Sixteen farmer networks are now using deep-rooted species to rehabilitate degraded soils.

A project that has introduced the Breedplan software, to identify superior genetic traits in cattle, has established a data base of pedigree and performance information for the past 20 years. Desired genetic characteristics can now be evaluated and estimated breeding **values calculated for economically important traits**. As a result, the Government of Thailand is using Breedplan to determine a national breeding strategy for native Thai, Brahman and crossbred cattle. This is a major payoff for the Livestock Department, which has been able to revolutionise the direction and operation of the major breeding stations in Thailand, replacing much of the traditional breeding practices of the Thai government and now the private sector. The involvement of village breeding programs has spread the benefits of the project across all types and sizes of cattle-raising enterprises. Thailand now considers itself as the leader in Breedplan and its use in Asian cattle herds.

The Thai component of the low-chill fruit project has concentrated on training and extension. Training courses have been conducted in pest management, with work also assessing the value of **small-mesh netting to protect fruit**. This has demonstrated that pesticide-free, high-quality fruit can be produced under netting. Links to supply chains and entry to retail markets are helping smallholders begin to see profits from selling peaches at $A4.00 per kilogram in local markets.

Through collaboration **with World Vision in Thailand** the results of a variety of ACIAR projects are being disseminated to smallholder farmers. Changes to horticulture practices have reduced chemical inputs, replacing these with organic alternatives. This is creating a niche market for growers who market their pesticide-free produce in local supermarkets in the Songkla Basin. Environmental impacts from run-off have also been reduced. Another initiative is helping increase smallholder fish production, to tap into local demand for freshwater fish. A third component is extending the low-chill fruit project to other groups of farmers in the northern Thai uplands. This is focusing on cash crops such as vegetables intercropped with fruit trees.

Transferring technology from a project on shrimp viruses has been undertaken, with farmers being shown positive and negative results from various technologies to **encourage them to adopt the improved methods**. High-quality shrimp production clusters are being linked to government and industry programs that emphasise quality. A cheap ELISA test for gill-associated virus has also been developed and is being field tested. As a result of this work the smallholder shrimp industry in Thailand is well placed to capitalise on market opportunities previously constrained by disease outbreaks.

Green ant predation is proving valuable as **a key element of integrated control** of mango insect pests. One type of green ant, the weaver, has proven to be the best species to use, with measures to control its aggressiveness (a major problem in harvesting) now developed and in practice. Integrated pest management (IPM) models have also been established for Thailand and Vietnam.

Thailand Plan 2004–05

(extract from ACIAR Annual Operational Plan 2004–05)

Population	61.6 million
GNI per capita	AUD 3,646

Thailand: Bilateral research expenditure	$m 2002-03 actual	$m 2003-04 budget	$m 2004-05 budget	$m 2005-06 indicative
Active projects	1.22	1.13	0.11	0.0
Committed funds for new projects			0.31	0.2
Projects under design			0.14	0.2
Available for new projects			0.00	0.0
Total	**1.22**	**1.13**	**0.57**	**0.4**

Strategy

ACIAR's Thailand program seeks greater implementation of the results of earlier projects (often in conjunction with NGOs) to ultimately benefit very poor farming communities. A second focus involves management of natural resources, especially in North and Northeast Thailand (including degradation by acidity and salinity as well as water resource management). In keeping with the graduation of Thailand as a recipient of aid, only a limited number of new activities, all of which will focus on implementation of the results of earlier ACIAR projects, will be considered in future.

Key performance indicators

- All new projects under development are focusing on implementation of results of earlier ACIAR projects
- Evidence of increased farmer involvement in projects on soil fertility management, crop production and fisheries
- Linkages through collaboration and training of Thai scientists to counterparts in neighbouring countries in at least three projects
- Effectiveness of on-farm shrimp disease control and management programs validated and extension through farmer networks initiated
- Enhanced Thai capacity in sanitary and phytosanitary policy issues

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. Over 10,000 hectares of suitable fast-growing Australian trees are planted each year as a result of ACIAR research.

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 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 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 for application of advanced biotechnologies and information technologies for agriculture are also emphasised. Opportunities to promote the application of technology, using both conventional extension methodologies and new approaches based on information technologies and agricultural modeling, were noted, especially for the benefit of farmers in upland northern Thailand and Northeast Thailand. The pathway for transferring project outputs to end-users should be included in the design and execution of projects.

Key program managers

Dr Ray Trewin, Agricultural Development Policy
Dr John Copland, Animal Sciences 1
Dr Ian Willett, Land and Water Resources

Country Manager

Ms Chiraporn Sunpakit, ACIAR Country Manager Cambodia, Laos and Thailand

Active projects

at 30 June 2004

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 Email: prema-chandra.athukorala@anu.edu.au
Collaborating Institutions	Research Information Systems for the Non-aligned and Other Developing Countries, India Thammasat University, Thailand University of Melbourne, Australia International Food Policy Research Institute, USA
Project Budget	$546,150
Project Duration	01/01/2002 to 31/12/2004
ACIAR Research Program Manager	Dr Ray Trewin

Project background and objectives

This study is examining the impact of sanitary and phytosanitary measures on the ability of (agricultural exporting) developing countries to achieve the full benefits of trade liberalisation. Particular emphasis is placed on the role of the Sanitary and Phytosanitary (SPS) Agreement and the related WTO dispute settlement procedure in cushioning exporters of agricultural and food products against trade-retarding effects of SPS measures, with emphasis on the related compliance issues and institutional constraints. The project is examining the trade impact of SPS standards, to distinguish between the degree to which that impact relates to the nature of SPS measures themselves versus the limited capacity of the governments and exporters in developing countries to comply with such measures. The study will yield important policy recommendations for further improvement of the current WTO procedure for SPS dispute settlement, and for enhancing technical, scientific and institutional capacity in India and Thailand. The issues also have particular relevance to Australia, a key member of the Cairns Group, in bridging the gap between agricultural exporting developing countries and developed countries in international trade talks.

Project progress

Year 2 (01/01/2003-31/12/2003)

The main tasks accomplished during the first year of the implementation period included:

- the literature survey;
- analysis of trends and patterns of processed food exports from developing countries and the WTO mechanism for monitoring food safety standards;
- the institutional mechanisms and procedures for meeting food safety standards in India and Thailand;
- case studies of the selected food industries in the two countries, and finalising the questionnaire for the firm-level survey.

The prime focus of the Indian and Thai research teams was on conducting the firm-level survey. The Indian team has completed surveying 23 firms. These include firms in the following industries: shrimp (12) mango pulp (4), egg powder (3) and mushroom (3) industries in the states of Kerala, Tamilnadu, Andra Pradesh Chandigar and Maharashtra. The Thai team has surveyed 24 Shrimp exporting firms and 3 caned tuna exporting firms.

The Australian team was mainly involved in finalising the two background chapters on the relative export performance of India and Thailand in world food trade, and the experience of developing countries in participating in WTO mechanism for monitoring international food safety, in addition to monitoring and coordinating field research in the two countries.

The Indian collaborating institution, Research Information Systems (RIS), held an in-country workshop in March 2004, to discuss the preliminary findings of the field survey and to provide inputs into the on-going policy debate in India on international food safety standards and the related WTO procedures. About 40 participants, representing food processing industry and relevant government organizations in India attended the workshop.

The second interim workshop was held in Bangkok during March 2004. In addition to the members of the research tem and ACIAR representatives, 23 government officials and private sector representatives in Thailand and four observers involved in an ongoing ACIAR project in Vietnam attended the public sessions on the first day of the workshop. The conference presentations included two country papers based on the preliminary results of the firm-level surveys in India and in Thailand, an overview paper on lessons of experience and new issues relating to international food safety standards and processed food exports from developing countries.

In addition, two invited papers were presented, one on the implications of Avian Influenza—a major new development that affected many Asian countries including Thailand in recent months—for world food trade and WTO issues, and the other on methodological issues involved in firm-level analysis of trade implications of food safety standards.

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
	Email: peter.warr@anu.edu.au
Collaborating Institutions	Bogor Agricultural University, Indonesia
	Centre for Agro-Socio Economic Research and Development, Indonesia
	National Center for Genetic Engineering and Biotechnology, Thailand
	Chulalongkorn University, Thailand
Project Budget	$399,799
Project Duration	01/01/2004 to 31/12/2006
ACIAR Research Program Manager	Dr Ray Trewin

Project background and objectives

Research on the socio-economic effects of technology development is a high priority in Thailand. This project aims to identify those agricultural industries that have shown productivity growth and determine why they have grown—is it biotechnical change such as improved crop varieties and cultivation methods, mechanisation, management improvements, or other reasons? Researchers will examine the economic and social effects of this technological change, including effects on agricultural trade, income distribution and poverty. They will assemble a large data set encompassing eight major agricultural sectors and undertake a statistical analysis of the rate and factor-saving biases of technical progress in each sector. They will also update and enhance the general equilibrium model of the Thai economy developed in an earlier ACIAR project, and use it to predict the economic and social effects of technical progress in each sector.

Project progress

The first progress report is due in early 2005.

AS1/1998/026: Lucerne adapted to adverse environments in China and Australia

Overseas Collaborating Countries	China, Laos
Commissioned Organisation	South Australian Research and Development Institute, Plant Research Centre, Australia
Project Leader	Dr Geoff Auricht
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Collaborating Institutions	Chinese Academy of Agricultural Sciences, China
	Gansu Agricultural University, China
	Shandong Academy of Agricultural Sciences, China
	Beijing Forestry University, China
	Gansu Grasslands Ecological Research Institute, China
	International Centre for Tropical Agriculture, Laos
	Department of Agriculture, Western Australia, Australia
	University of Tasmania, Australia
Project Budget	$938,899
Project Duration	01/01/2001 to 30/06/2005
	(Project extended from 01/01/2005 to 30/06/2005)
ACIAR Research Program Manager	Dr John Copland

Project background and objectives

Forage production is one of the key limiting factors to increased animal production across vast areas of China. Fertile areas are almost exclusively cropped, with pasture production restricted to marginal areas. Factors such as overgrazing (northern temperate grasslands), salinity and waterlogging (Yellow River Delta) or acid soils (Southern China) are prevalent, and result in poor pasture production. A well-adapted, deep-rooted perennial is urgently required to maintain productivity and arrest soil problems in these areas. Lucerne has great potential to alleviate these problems in both China and Australia and research is currently under way for expanded areas in Australia, including the cereal zone. However, there is a specific need to develop varieties with high levels of tolerance to factors such as salt, acid/aluminium soils, waterlogging or drought. This project aims, through the development and utilisation of improved lucernes (particularly for challenging environments) to improve animal production and environmental stabilisation in China and Australia. The scope of the project has been extended to identify if lucerne is suitable for use as a forage crop in Laos. The project work, in northern Laos, is investigating small-scale lucerne production in niche environments in subtropical upland areas. Work is underway, evaluating lucerne germplasm for use as forages and seed production.

Project progress

Year 3 (01/01/2003-31/12/2003)

Acquisition and field testing of Germplasm

A total of 40 new lines were added to the list of germplasm being used in the project. The germplasm list now contains over 200 lines from a wide variety of sources. Seventy lines are now being multiplied in Australia and 53 lines are being multiplied at 2 sites in China. Seventy-one lines from the list are being fully characterised in Adelaide in collaboration with the SARDI Genetic Resources Collection (GRC) at the Waite Campus. A further 73 lines that were collected during the germplasm collection mission in Kazakhstan in 2002 are being characterised at the same time, again in collaboration with the SARDI GRC.

Soil samples taken from all field sites in China were characterised for physical and chemical properties by the SAAS collaborators. Sub-samples of this soil were sent for rhizobial characterisation in Adelaide. At almost all sites, soils contained rhizobia that were effective on Chinese and Australian lucernes. This is a good result as it implies that extensive inoculation

is not required when planting lucerne in the project areas in China. Further characterisation, of both rhizobial performance and diversity, will be carried out in 2004.

A new field trial was planted near Dongying in China. Measurement and assessment of trials has continued at the sites in China and Australia. As the existing trial measurement protocol was found to have some deficiencies, it will be changed in 2004 so that a uniform measurement protocol can be used across all sites. Pest and disease characterisation continues at the Gansu Agricultural University trial in Lanzhou.

Developing novel screening techniques

The UTAS collaborators in Hobart continued the physiological characterisation of the response of lucerne to waterlogging and salinity stress. Part of this work has utilised the PAM fluorometer together with other physiological measurements to characterise the response of lucerne plants to waterlogging stress. A further paper on this waterlogging work was submitted. An experiment was carried out using an extensive range of parameters to characterise the response of lucerne lines to salinity treatments. The purpose of this work was to further validate the use of the PAM fluorometer as a salinity-screening tool, developing the salinity screening method for large-scale screening. The hydroponic system used for aluminium screening was adapted for salinity work and 10 lines were screened during November. Based on the results, a subset of this material was selected and planted out to assess long-term salinity tolerance over December and January. The aluminium screening technique has progressed well. The experiments involved in the development of the screening method form the basis of a paper to be submitted in early 2004. As hypothesised, no difference in acid/aluminium tolerance has been found between populations but there has been considerable variation within lines which can be exploited to breed an aluminium tolerant cultivar. Over 10,000 individual plants have been screened thus far with this method and selections have been taken. Seed will be produced from crossing the selected material and the progeny will be tested to assess the heritability of the measured trait.

Training Chinese researchers, publish lucerne improvement findings and extension course

The 3rd project meeting was held in Hohhot in July. Part of the meeting was devoted to methodological considerations and the theoretical and practical issues involved in trial measurement and this was followed up with discussions at the project trial sites during the field visits. Considerable time was also spent on planning papers resulting from the project work. Part of the 2004 project work will be facilitating the writing of a paper (in English and Chinese) on trial results at each for each field site.

Project related papers published in Chinese journals.

Project activities and research have featured in a number of articles in Australian electronic and print press. Project research was presented at 2 Australian conferences. Project activities were presented as papers at the Chinese alfalfa conference.

Project work in Laos

The project has begun field work through the existing Forages and Livestock Systems Project, run by the International Center for Tropical Agriculture network, previously established. Through this collaboration farmers are being introduced to lucerne germplasm to trial in small plots. These trials are being extended to feeding livestock and measuring growth rates, to determine suitable varieties.

Germplasm has been pre-tested to screen out deficiencies, with around 150 accessions tested at five nursery sites throughout Laos. The most promising of these lines have been planted in regional nurseries, with a small group of robust and broadly adapted varieties, suited to upland conditions, being trialled by farmers involved in the project.

AS1/2002/099: 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
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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	$149,554
Project Duration	01/01/2004 to 31/12/2005
ACIAR Research Program Manager	Dr John Copland

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

The first progress report is due early in 2005.

AS1/2003/001: Management of CSF and FMD at the village level in Lao PDR

Overseas Collaborating Countries	Laos
Commissioned Organisation	CSIRO Livestock Industries, Australian Animal Health Laboratory, Australia
Project Leader	Dr Laurence Gleeson
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Collaborating Institutions	International Centre for Tropical Agriculture, Department of Livestock and Fisheries, Laos
	Department of Livestock and Fisheries, National Animal Health Centre, Laos
	University of Melbourne, Faculty of Veterinary Science, Australia
Project Budget	$399,329
Project Duration	01/07/2003 to 30/06/2006
ACIAR Research Program Manager	Dr John Copland

Project background and objectives

The livestock diseases Classical Swine Fever (CSF) and Foot and Mouth Disease (FMD) are major constraints to village livestock production systems in Lao PDR. A previous project (AS1/1994/038) identified CSF as causing substantial deaths in village pig production systems. This project aims to introduce a CSF vaccination program at the village level, together with husbandry strategies to maintain herd immunity against future disease outbreaks. The development of a simple, rapid diagnostic test will be combined with implementation of a village-centred vaccine delivery system. Epidemiological data will be gathered to build national and regional understanding of both CSF and FMD, and simple extension materials for animal health and production services produced.

Project progress

The first progress report is due late in 2004.

ASEM/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
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Collaborating Institutions	Cambodian Department of Agricultural Extension, Cambodia
	Cambodian Agricultural Research and Development Institute, Cambodia
Project Budget	$307,554
Project Duration	01/07/2001 to 30/06/2005
	(Project extended from 01/07/2003 to 30/06/2005)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

In common with many other Asian countries, Cambodia suffers large crop losses from voracious rats. This project aims to combine scientific knowledge with community action research to achieve improved rat management in Cambodia. It builds upon previous ACIAR work on rodent control within Southeast Asia, which now has many strong collaborative links through the region. The project is designing rodent pest management strategies that are consistent with the ecological, socio-economic and technical constraints faced by local farmers. This is improving the capacity of the Cambodian Agricultural Research and Development Institute (CARDI) to work co-operatively with local communities to conduct agricultural research for the design of a strategy for achieving improved rat management through community-level interventions in conjunction with other agencies in Cambodia.

Project progress

Year 3 (01/07/2003-30/06/2004)

Development of methodology and extension material and training material

A working draft of the methodology training course was developed and refined by conducting a training course based on the draft. A training course/workshop was conducted on Participatory Research and Extension by project team members from Australia in Cambodia in March and April, with 11 trainees from the Cambodian Agricultural Research and Development (CARDI), the Office of Agricultural Extension (OAE) and the NGO, CHE (Community Health Education) attending.

The training followed an action learning approach and covered participatory community engagement, participatory methods of learning and exploring issues with communities and participatory evaluation. Training focussed on participation with an emphasis on how to engage the community on rodent management issues. From this training course a manual and complementary CD are being developed for use by trainers in Cambodia for use in participatory research and extension techniques.

Drafts of technical extension material for the use of the Trap Barrier System (TBS), specifically for Cambodian conditions, have been completed for publication as extension material by CARDI. The materials developed by this project will be made available to other agricultural agencies within Cambodia.

Monitoring of the treatment site

During the past 12 months the project team has been continuing with monitoring of the treatment site where farmers have continued to trial the TBS technology without monetary support from the project. Technical data was collected for the 2003 wet season (ending in

September) to continue evaluation of the effectiveness of the TBS method for rat management. Project team members are also continuing to monitor and document the adaptation of the technology and certain socio-economic aspects surrounding the technology and rat management.

Socio-economic analysis in the reporting period has concentrated on the management of rodent pests as a common property resource management problem. This work has been conducted primarily during field work at Samrong and L'vea Communes, leading to a close relationship with the farming community and greater understanding of how the communities organise other aspects of community life involving groups. This field work has also contributed to understanding of how the TBS fits into the farming system in the study area.

The team conducted a participatory evaluation of the level of participation as perceived by the farmers involved with the project. One of the overall intentions of the project was to have community involvement in all stages of the project. This evaluation helped the project team to understand what level of participation had been achieved and what impact this has had on the community. The evaluation considered the distribution of the work load within the project and the distribution of project benefits. Farmers considered that project costs and labour were shared and showed an appreciation of research findings as project benefits falling to the farmers as well as scientists. Farmer meetings and supporting visits by OAE and CARDI staff have maintained interest in the project, despite the lack of financial support for TBS construction. Farmers at L'vea Commune were not willing to participate in TBS activities without financial support for materials. Despite this initial reaction, there has been a level of interest and activity at L'vea and limited continued TBS operation in Samrong Commune.

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: 02 6763 1258 Email: bob.martin@agric.nsw.gov.au
Collaborating Institutions	Cambodian Agricultural Research and Development Institute, Cambodia
Project Budget	$887,591
Project Duration	01/07/2003 to 30/06/2007
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

The Cambodian Agricultural Research and Development Institute now has a strong mandate from the national government to increase research focus on upland (non-rice) crops. However researchers, extension workers and farmers in Cambodia have little experience in relation to such crops. While Cambodia is pushing to diversify from the core cereal crop (rice), the Tamworth Centre for Crop Improvement in NSW is examining cultural and crop-choice decisions for growing crops other than wheat in that region of northern NSW. Leading farmers in this region are diversifying away from wheat and moving to no-tillage land preparation methods, with positive economic and environmental consequences, and NSW Agriculture desires to hasten the change process. This project is linking with, and improving, existing educational and extension initiatives. The proposed rotations of cereal, legume and oilseed crops allow a reduction in cultivation, increased groundcover and reduced erosion. Methods of analysis and conceptual frameworks to be used for bringing about change will be similar for the very different conditions of the northern NSW wheat belt and Cambodia.

Project progress

Year 1 (01/07/2003-30/06/2004)

A household survey was carried out in Kampong Cham (Chamkar Leu and Tbaung Khmom Districts) and Battambang (Sampov Loun, Kamreang and Phnom Proek Districts) in 2003–04 to determine:

- farming systems practised;
- impact of upland crops on farm incomes and the utilization of farm resources;
- potential for improving both yield and productivity of upland crops; and
- constraints to crop production.

Initially, a pilot survey was carried out with 16 households in Kampong Cham and 20 in Battambang to test the methodology. The main survey involved a total of 162 households (70 in Kampong Cham and 92 in Battambang). These surveys have been completed and the data entered onto spreadsheets for analysis.

In Australia, 131 farmers and advisers in the Moree, Inverell, Narrabri and Gunnedah districts were surveyed revealing the main reasons farmers have for not growing chickpeas and faba beans. These are the risk of disease, the cost and hassle of fungicides and concern over broadleaf weed management. A major limit to faba beans was the lack of a suitable variety and price that are too low and variable. The price of chickpeas was considered too variable. The main concern for canola was the lack of suitable harvest equipment followed by concern over broadleaf weed management. The respondents consistently gave a low ranking (i.e. not a limiting factor) to agronomic information and being convinced about the benefits of these alternative crops.

Farming systems research priorities for the field experiment program for upland crops in Cambodia in 2003–04 were drawn from Agro-Ecosystem Analyses, consultation with Office of

Agricultural Extension, Provincial Department of Agriculture, Forestry and Fisheries and CARDI. Crop production issues identified were

- a lack of suitable varieties of upland crops;
- susceptibility of local varieties to insect pests and diseases;
- lack of nodulation or poor nodulation of legumes with rhizobia;
- excessive and possibly unnecessary tillage on the friable/erodible upland soils.

The field experimental program in Cambodia in the 2004 wet season has involved a total of 35 experiments: 16 variety trials; six experiments to evaluate resistance to major pests; nine rhizobium inoculation experiments and four reduced tillage experiments.

In June 2004, members of the Cambodian and Australian project team visited Thailand to acquire germplasm of soybean, corn, sesame, peanut, mungbeans and cowpeas for evaluation in Cambodia. The team also inspected tillage research rhizobium inoculation techniques.

The project is developing simple diagnostic tools for farmers and advisers in Cambodia. These can be as simple as push probes to estimate the depth of wet soil, pH kits, rain gauges and germination tests of seed kept for sowing. Photographic records are being compiled for the identification of insect pests and diseases. At the Australian end of the project, work commenced on a CropChoice spread sheet decision aid. The CropChoice spread sheet has been developed to combine paddock data, scientific knowledge and economic and marketing information to assist the farmer in crop choice decisions.

Reduced or zero-tillage has the potential to improve soil water storage and reduce erosion on upland soils in Cambodia. Early results of tillage experiments have shown that yields of upland crops planted by zero-till are equal to yields after conventional cultivation. Reduced cultivation has the potential to reduce the risk of sowing upland crops at the break of the wet season. Experiments are planned for 2005 to determine if the risks of planting early can be reduced by practices aimed at increasing soil moisture storage.

A benchmarking (crop check) study was carried out in northern NSW in 2003. The results are being used to aid growers in decision making. For chickpea crops in 2003, the variables most associated with yield were found to be plant available water; stubble cover and rhizobium nodulation. Frosts occurring late in the season were also particularly detrimental to some crops. Benchmarking in the farmer's paddocks showed yield loss from delayed seeding to be 30 kg/ha/day or over 600 kg/ha/month. Thus delayed sowing for one month would cost the grower $160/ha if chickpeas were worth $270/t. A draft crop-check protocol has been prepared for soybeans under Cambodian conditions and is being evaluated in 2004.

The New South Wales Department of Primary Industries Agfact publication series is being used as a model for developing technical information packages for the 6 focus crops in Cambodia (corn, soybean, mungbean, cowpea, peanut and sesame). A draft mungbean Agfact has been circulated to project team for input.

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

Overseas Collaborating Countries	Laos
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Collaborating Institutions	National Agriculture and Forestry Extension Service, Laos
	Department of Livestock and Fisheries, Laos
	International Centre for Tropical Agriculture, Laos
	Department of Livestock and Fisheries, Laos
Project Budget	$394,476
Project Duration	01/07/2003 to 31/12/2005
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Throughout the uplands of Southeast Asia farmers in shifting cultivation areas face major challenges to sustain their livelihoods, largely due to pressures of increasing population, resource scarcity and land degradation from shortened fallow periods. Decentralised participatory research and extension can instruct and encourage farmers, enabling them to innovate and make changes to benefit these farming systems. But progress is only possible through an increase in the capacity of national research staff and their organisations, so that they can introduce effective gender-sensitive participatory approaches. This project is conducting research in the mountainous northern uplands of Lao PDR.

Project progress

Year 1 (01/07/2003-30/06/2004)

The Accelerating Impacts of Participatory Research and Extension Project focused key activities on understanding how and why some farmers are modifying their upland farming systems away from a reliance on shifting cultivation and trialling different methods for accelerating and spreading the impacts of participatory research (scaling out). Literature has been reviewed and compiled on changes in shifting cultivation in Southeast Asia and Laos; upland livelihood systems; land allocation policies; livestock production and rural development. This literature review provides background information to understand the context, and will direct further research questions for farmer interviews.

Twenty one case studies have been developed to document the range of impacts emerging from farmers using forages for livestock. These impacts cover a range of environmental, economic and social benefits to upland households (eg reduction in labour, increase in livestock weight gain, lower calf mortality, less damage to crops from wandering stock, increased income, healthier livestock etc). District staff working with villages in four districts across two northern provinces selected farmers to interview based on significance of the impacts across a range of livestock types (cattle, goats, buffalo, pig) and forage varieties. Nine of the case studies have been used as an extension tool to demonstrate potential system changes to new villages.

Key activities in scaling out have centred on farmer group development, cross visit methodology, entry approaches for new villages and ongoing support for more experienced farmers and villages. A methodology has been developed by staff to encourage the formation of farmer groups based on their interest in developing either small animal or large animal production systems. Workshops were held separately with all district teams in December 2003 to develop indicators of group effectiveness and then rate each village group according to the nominated indicators.

T his exercise generated discussions on the factors influencing group development and effectiveness in achieving on-ground impacts. During the reporting period, cross visits have involved taking farmers from new Forages and Livestock Systems Project (FLSP) villages to visit farmers already experiencing impacts (two or more years in FLSP). Opportunities have also been created for experienced farmers to meet and exchange information with 'champion' farmers from other villages and districts with subsequent adoption of technologies and management of new systems. All these activities have involved staff training and mentoring in planning, implementation and review using action learning principles.

Three new entry approaches have been trialled with new villages in 2004. The aim is to introduce new farmers to systems not just forages, to accelerate the extension process and get groups up and running early on so farmers can support one another. These methods all start with a problem diagnosis and follow up with either Case Study photos and system sketches, or Cross Visit to village with impacts or Case Studies with a champion farmer talking.

Comparisons of the effectiveness of these three methods for accelerating farmer innovation and impacts will be made during the next reporting period. A book proposal has been submitted to ACIAR publications which will provide guidelines on the best approaches to use to accelerate impacts using participatory research and extension.

Another aspect of the project is to facilitate and understand organisational learning requirements for participatory research and extension. This has had less activity during the reporting period. Key activities have occurred at the district and provincial level with staff involvement in training and on the job learning.

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

Overseas Collaborating Countries	Cambodia
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Collaborating Institutions	Ministry of Commerce, Cambodia
	Cambodian Development Resource Institute, Cambodia
Project Budget	$399,949
Project Duration	01/07/2004 to 31/12/2006
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Maize and soybeans are the main non-rice crops grown in Cambodia. The dominance of rice means infrastructure and knowledge to support maize and soybean, including markets, postharvest skills and information is limited. Expanding the production of non-rice crops is supported by the Government. Production of maize and soy has increased mainly through the opening of new land for cultivation, but has yet to reach its potential. An inadequate marketing system, to support the emphasis on non-rice crops as cash crops has hampered this potential further. Mapping existing marketing systems and supply chains will help identify constraints limiting growth and will be used both to initiate change and boost Cambodian research capacity.

Project progress

The first progress report is due in 2005.

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

Overseas Collaborating Countries	Cambodia, Laos
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Collaborating Institutions	Cambodian Agricultural Research and Development Institute, Cambodia
	National Agriculture and Forestry Research Institute, Laos
	International Rice Research Institute, Philippines
	CRC for Sustainable Rice Production, Australia
Project Budget	$1,291,106
Project Duration	01/07/2000 to 30/06/2005
ACIAR Research Program Manager	Dr Colin Piggin

Project background and objectives

Much was achieved to increase rice-productivity in an earlier project 'Plant breeding strategies for rainfed lowland rice in Northeast Thailand and Laos'. This project will continue the work of increasing the productivity of the rice-based cropping systems in Lao PDR, Cambodia and Australia. Plant breeding strategies for lowland rice and intensification of rice-based cropping systems in rainfed lowlands is underway. The project is also developing direct seeding technology and increasing the productivity of dry season irrigated rice. Agro-ecological maps for Lao PDR that provide basic climatic, water balance and soils information that can be used for setting the directions for future crop research and policy making are also under development.

Project progress

Year 4 (01/07/2003-30/06/2004)

Plant breeding strategies for rainfed lowland rice

Rainfed lowland rice is the main rice production system in Laos and Cambodia and the objective was to minimize the constraints for lowland rice production in the Mekong region through new breeding strategies for the development of varieties tolerant to drought and low soil fertility. Extensive multi-location experiments for grain yield were conducted over four years at eight locations using 16-32 lines from various sources. The combined analysis with 2003 wet season data revealed a strong relationship between yield reduction and water deficit at flowering for rainfed lowland rice in Cambodia. The grouping of environments in multi-location trials was not associated with soil type, but with water availability at flowering. A new method of quantifying water availability at flowering was developed, and this assisted in the environmental characterisation for multi-location trials. This technique also enables the testing of breeding populations for drought adaptation.

Intensification of rice-based cropping systems in rainfed lowlands

The development of double cropping systems to increase on-farm productivity is vital for farmers in Cambodia and Laos. Experiments have been conducted since 2001 in wet and dry seasons to examine the most successful and low risk cropping systems. In Cambodia, areas with high rainfall or supplementary irrigation had a low risk of double cropping for rice in the early wet season (EWS) and wet season (WS). There was a high risk of crop failure of EWS rice in low rainfall areas where supplementary irrigation was not available. Rice-rice double cropping was possible for most areas where good rainfall was received in early April in EWS. There were difficulties for double cropping mungbean with rice in the WS due to high rainfall causing water-logging in the EWS and drought conditions in the dry season (DS).

Experiments were also conducted at four locations in 2003 in northern Laos to explore the likelihood of rice-rice double-cropping under irrigated conditions. Crop establishment in the DS was successful when the mean minimum temperature was above 12°C. The annual grain yield was increased to 8-9 t ha-1 when rice-rice double cropping was adopted under irrigated condition.

Development of direct seeding technology

The specific objective of experiments in 2003 was to investigate the characters and mechanisms associated with genotypes adapted to direct seeding. In the 2003 wet season, the effect of weed competition on grain yield and the relationship between stem diameter and lodging were investigated among 34 genotypes, which were direct seeded at three locations in Cambodia. The yield was similar under direct seeding when weeded 30 days after sowing to that of transplanted crops. Varieties that had a small first internode length had a low risk of lodging under direct seeding.

Increasing productivity of dry season irrigated rice

The increase in rice-rice double cropping in northern Laos has meant farmers are encountering new problems in the dry season (DS), primarily related to low temperature during seedling establishment. Experiments at different locations were conducted in the 2003–04 DS to investigate ways to improve seedling establishment for DS rice. The relationship between establishment temperature and seedling growth showed that when the mean minimum temperature was below 12°C the rice crop was more likely to have poor establishment. Seedlings were protected from low temperature in the nursery with a plastic sheet applied as a flat cover and also as a dome. On-farm experiments showed the higher yields resulted when seedlings were established under the plastic dome compared to conventional farmer practice. The plastic dome could also increase sowing flexibility by reducing the duration of seedlings in the nursery by 20 days.

Agro-ecological characterisation

In the rainfed lowlands, where droughts and flood problems are related to water availability in the field, rainfall is an important climatic factor. Rainfall, temperature and potential evapo-transpiration GIS maps have now been completed for Laos. In 2003 these factors were used to produce GIS maps, which showed the length of growing period for Laos. GIS maps are now being combined with crop models in Savannakhet in southern Laos to examine the limits to high yield potential, particularly caused by water deficit. Climatic factors, particularly rainfall and temperature, and factors associated with water movement within and between rice paddies are identified as the key for agro-ecological characterisation of lowland ecosystems.

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

Overseas Collaborating Countries	Laos, Thailand, Vietnam
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Maroochy Horticultural Research Station, Australia
Project Leader	Dr Alan George
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Collaborating Institutions	National Agriculture and Forestry Research Institute, Laos
	Department of Agriculture, Thailand
	Research Institute of Fruit and Vegetables, Vietnam
	National Institute of Plant Protection, Vietnam
	Southern Fruit Research Institute, Vietnam
Project Budget	$388,981
Project Duration	01/07/2001 to 30/06/2004
ACIAR Research Program Manager	Dr Colin Piggin

Project background and objectives

This project is a new project in Laos and Vietnam, and an extension in Thailand of the original project CS1/1994/947. That project used a multi disciplinary, holistic approach to solving and developing sustainable temperate fruit industries in Australia and Thailand. The results highlighted a number of new issues to be addressed, particularly in the area of continued technology transfer and germplasm exchange to Thailand. Laos and Vietnam are keen to develop their fledgling temperate fruit industries. The transfer of fruit production technologies to upland regions of both Laos and Vietnam are government priorities and are being undertaken in the current project. The earlier project identified the key technical problems limiting further expansion of temperate fruits in Thailand and similar problems in Vietnam and Laos. These problems were: use of high-chill rootstock in low-chill regions, boron deficiency, severe water stress and lack of a suitable pest and disease spray programs. Four climatic zones for temperate fruit production in subtropical regions have been identified in Australia, Thailand and Laos: very low-chill, low-chill, medium-chill, and high-chill. In Vietnam, very high-chill regions also exist which could successfully grow Californian and other higher-chill varieties. In this project a wide range of species (plum, peach, nectarine, pear, and persimmon) and varieties have been introduced into Vietnam and Laos to replace poor quality, locally-grown cultivars. The varietal base in Thailand has been expanded with additional species and cultivars introduced from Australia. There is a major focus on technology transfer, through definition of specific phenological cycles for different species grown in Laos and Vietnam; trialling of growth retardants and rest release chemicals; production of a decision support manual; further training through workshops, trial field plantings and demonstrations; and development of market plans for Laos and Vietnam.

Project progress

Year 2 (01/07/2002–30/06/2003)

Over 1300 stonefruit trees of 25 varieties of peach, plum, nectarine and persimmon have been sent to Vietnam and Laos. About 70% of these trees have now been field-planted at four arboreta sites in Vietnam and two arboreta sites in Laos with a wide range of chilling;

Vietnam is aiming to double its temperate fruit production area to 10,000 hectares within the next 5-10 years. In addition to growing low-chill temperate fruits, it has been observed that Vietnam can also grow high quality medium-chill cultivars of stonefruit. High quality medium-chill plum cultivars Black Amber, Simca and Fortune are performing well at Sapa. Under good management systems these varieties should produce late-season fruit in July and will complement the early-season production (March-May) from the lower-chill regions.

Local germplasm has also been identified in both Laos and Vietnam, which may be suitable for breeding because of its disease resistance and quality characteristics.

Non-astringent persimmon has been identified as a potential new commercial crop for Vietnam, Laos and Thailand. Better-adapted rootstocks have been identified in Vietnam. These appear to be better suited to the red ferralitic soils than the commonly used Australian rootstocks which have failed to establish quickly in Thailand on similar soil types. The cultivar Fuyu has been identified as the best variety for commercial production.

Important temperate fruit germplasm has been identified in Laos and Vietnam. Many local selections have resistance or tolerance to some of the major leaf diseases. Germplasm of two selections has been imported in Australia and will be incorporated into the low-chill peach-breeding program.

Commercialisation of temperate fruit production in Thailand is in progress. The peach cultivar Tropic Beauty has performed well and is being commercially produced by Hill tribe villagers in Chiang Mai and Khun Wang. Recently established cool storage facilities in Ang Kang and the use of refrigerated trucks to transport the fruit to the larger cities of Chiang Mai and Bangkok has ensured that high quality fruit is reaching the consumer. Agro-tourism is also being successfully developed in these regions, with temperate fruits being a major tourist attraction.

Key management practises for growing temperate fruits in Thailand, Laos and Vietnam have now been developed. The major pests and diseases identified are similar to those found in Australia. Senior research and extension staffs in the collaborating agencies in Thailand, Laos and Vietnam have been trained to identify the most serious pest and disease problems and to undertake appropriate control programs.

Extension officers and farmers have also been trained in pre-harvest production methodologies. Further training is need in supply chain management and quality assurance programs.

In Thailand and Vietnam, bait programs were highly successful in controlling the most serious pest, fruit fly.

Varieties introduced from Australia as part of the ACIAR project are receiving double the price of locally produced varieties, because of their higher quality. For example, nectarines, which no one had eaten before in Laos, were sold at 5000 k/kg in Nong Het and 8000 k/kg (about AUD1.20/kg) in Phonsavan. In Thailand, high quality Tropic Beauty peaches were retailing for AUD4/kg in the Chiang Mai markets.

Nine training courses were conducted in Thailand, Laos and Vietnam in 2002–03 for local technicians, extension and research officers and farmers from Lao Cai, Son La and Ha Giang provinces in Vietnam, Nonghet province in Laos and Ang Kang, Thailand. Trainees were taught cultivation, orchard management and crop protection techniques for low-chill temperate fruit trees.

Year 3 (01/07/2003 – 30/06/2004)

The project was externally reviewed in April 2004, and will be extended in Thailand and Laos to consolidate and refine low-chill fruit production technologies in Laos and encourage their uptake in Thailand and Laos. Technology refinement and extension in Vietnam will be supported by ACIAR through a project, PHT/2002/086 *Improving postharvest quality of temperate fruit in Vietnam and Australia*.

CP/1997/079: Integrated control of mango insect pests using green ants as a key element

Overseas Collaborating Countries	Thailand, Vietnam
Commissioned Organisation	Charles Darwin University, Faculty of Science, IT and Education, Australia
Project Leader	Associate Professor Keith Christian
	Phone: 08 8946 6706
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Collaborating Institutions	Prince of Songkla University, Thailand
	Department of Agricultural Extension, Thailand Southern Fruit Research Institute, Vietnam
Project Budget	$655,210
Project Duration	01/01/2001 to 30/06/2005
	(Project extended from 01/07/2004 to 30/06/2005)
ACIAR Research Program Manager	tba

Project background and objectives

Mango growers use chemical insecticides to control mango pests, but with increasing environmental and economic problems. Traditionally in Asia the pests were kept under control by manipulation of colonies of predacious green ants in orchards, and this project seeks to reintroduce the old technology, with adaptive research to improve it. Following success with this approach in cashew plantations, this project is surveying mango pest populations in the presence and absence of green ants, undertaking field observations and laboratory experiments on interactions of the ants with mango insects, and conducting field experiments with transplanted ant colonies. Scientists are developing limited insecticidal treatments to control sap-sucking insects (which the ants encourage rather than attack), and also studying measures to prevent the ants stinging humans as the fruit is harvested. The research team is preparing instructional material (printed and video) and organising some farmer field schools.

Project progress

Year 3 (01/01/2003-31/12/2003)

All the identified outputs in this reporting period have been successfully achieved. The data obtained in the field monitoring and field experiments in 2003 in the Australian program demonstrated that similar yields and better quality of fruits were achieved from trees with weaver ants plus soft chemicals (51.8 fruits/tree and 62.6% of first class fruits) compared to trees protected by chemical insecticides (42.6 fruits/tree and 40.9% of first class fruits). Higher yields and better or similar quality of fruits were produced in trees with abundant weaver ants (45.8–61.4 fruits/tree and 58.4–68.5% of first class fruits) than in trees without weaver ants (51.5 fruits/tree and 39.8% of first class fruits). Sugar levels are higher in fruits from the weaver ant plus soft chemical treatment than in fruits of the insecticide treatment. Similar results were also obtained in the Prince of Songkla University program.

Weaver ants were effective in controlling the major mango insect pests compared to chemical insecticides and other ant species. However, the ants have a mutual relationship with scales and mealy bugs. The parasitic level of the plant hopper was higher in trees with weaver ants plus soft chemicals than in trees protected by chemical insecticides, which agree with the data obtained in 2002.

The soft chemicals, Applaud (0.03%), Potassium soap (1%) and White oil (2%) were effective in reducing mealy bug populations and are safe to weaver ants. A pure water spray at a rate of 2000 L/ha can reduce weaver ant activity by more than 70% for 50 minutes, which greatly reduces ant disturbance to people picking fruits. In Thailand, a long handle picking pole or net used with a shaking action reduces ant aggressiveness.

To stabilise weaver ant populations in mango orchards, data obtained by the collaborators at the Prince of Songkla University suggested that weaver ant populations have been more stable in the mixed cropping orchard than in the monoculture orchard. Field experiments in the Australian component of the project were completed in November 2003, and the data analysis is in progress.

A preliminary integrated pest management (IPM) model constructed in 2002 has been tested in 2003, and a final model for Australian mango growers has been developed. Based on two years of data and on-going study, two preliminary models have been constructed for Thailand and Vietnam respectively.

The group is actively involved in publications, communications, dissemination and extension activities. A video for Australian mango growers has been made. Videos in Vietnamese and Thai are under preparation. Posters and booklets are also under preparation.

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

Overseas Collaborating Countries	Laos, Thailand, Vietnam
Commissioned Organisation	World Vision Australia, Australia
Project Leader	Mr Graham Tardif
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Collaborating Institutions	Laos World Vision Foundation, Laos
	World Vision Foundation of Thailand, Thailand
	World Vision of Vietnam, Vietnam
	University of Queensland, Australia
	Queensland Department of Primary Industries and Fisheries, Maroochy Horticulture Station, Australia
	NSW Fisheries, Australia
Project Budget	$1,267,261
Project Duration	01/01/2001 to 05/03/2007
	(Project extended from 01/01/2004 to 05/03/2007)
ACIAR Research Program Manager	Dr John Skerritt

Project background and objectives

The emphasis of this project is to increase the impact of ACIAR project results through provision of technologies arising from ACIAR projects, by interacting with World Vision (WV) projects operating in appropriate provinces/districts in partner countries. 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 initiatives between ACIAR and WV in three partner countries. In each case, the emphasis is on integration of results arising from a mature or completed ACIAR project activity (which would gain from farmer-level extension of the results) into an active WV project in particular provinces of an ACIAR partner country (which requires particular technology interventions) .

The Thai components—*Agricultural reform to prevent agrochemical pollution of water resources, High-value, low chill temperate fruits for hill areas of northern Thailand* and *Profitable fish farming through utilisation of low-cost feeds*—utilise technologies developed in several current or completed ACIAR projects to assist in the 'technical underpinning' of the WV activities associated with this project in Thailand. Similarly, in Laos—*Improving crop yields in rainfed rice-based systems in central and southern districts of Laos*—is underpinned by past ACIAR-funded research.

Project progress

Year 2 (01/01/2003 – 31/12/2003)

Agricultural reform to prevent agrochemical pollution of water resources (southern Thailand):

The project's operation has been successful in bringing awareness to the vegetable farmers the dangers of using chemicals in vegetable growing. Presently, the farmers have better understanding that the chemicals are harmful to their health as well as to the consumers. Thus, they have tried using various methods to improve their production process by soil management, setting water system prior to planting, revolving planting different plants (plant rotation) to improve soil, using organic fertilisers, etc. Although they have not been able to stop using chemicals entirely, they have greatly reduced its use. More than 1,000 farmers in Chian Yai district, Nakhon Si Thammarat province have benefited from the knowledge they received from the project through training, study tours and the dissemination of publication documents. The two hundred members of the "chemical-free vegetable producer's fund" under the supervision of World Vision Chian Yai Agricultural Cooperatives will be able to grow and carry out the work in a sustainable manner.

High-value low-chill temperate fruits for hill areas of northern Thailand:

Public interest for the project grew and popular involvement increased steadily, most evidently in 2003. This was offset by low prices of fruits produced due to their native origin, which means high vulnerability to local pests and the decline in productivity. Replacement of traditional fruits with peaches of good breed was introduced by the project as a way-out, hence ameliorating the problem and promising farmers a hope of better yields. This was collaboration between the project and Chiang Mai Royal Agriculture Research Centre. A team of ACIAR officers visited the project in the previous year, educating farmers in techniques of pruning and tending of fruits which the project has sought to promote.

Profitable fish farming through utilisation of low cost feeds (NE Thailand):

By June 2003, centres for training and demonstration in fish farming emerge in 2 target sub districts namely Kok Sa-ard sub district in Prasart district, Surin and Hnong Na Kam sub district in Muang district, Udornthani to disseminate knowledge and provide consultancy with regard to fish farming. Activities by the centres are continuous and efficient, with cooperation of governmental agencies, educational institutions and community organizations in these sub districts, aiming primarily at promoting the use of appropriate technology and cost reduction. By June 2003, fish farming is extended to and adopted by 500 families in both target subdistricts. The project is now embarking successfully upon the preparation and extension of fish farming for self-sufficient livelihood to new areas of project expansion.

Improving crop yields in rainfed rice-based systems in central and southern districts of Laos):

As a result of the dry crop season training farmers are now able to grow dry season crops for consumption and for sale. In total, according to government counterpart reports 1663 kg of crops were grown between Jan and March with a total retail value of 3,989,000 kip (approx 360 USD). In the second half of this reporting period peanuts, green beans and wheat had also been planted and total crops harvested totalled 567 kg with a value of 625,000 kip (60USD). Following the wet season training and seed distribution it was noticed that the farmers were working hard to use the lessons learnt in their training. By the end of June all the farmers who received seeds from the project had completed sowing using approximately 85% technically correct method.

CTE/2003/007: Cambodian Agricultural Research Fund

Overseas Collaborating Countries	Cambodia
Commissioned Organisation	Consultant, Australia
Project Leader	N/A
Collaborating Institutions	Cambodian Agricultural Research and Development Institute - Assistance Project, Cambodia Cambodian Agricultural Research and Development Institute, Cambodia Royal University of Agriculture, Cambodia University of Tropical Agriculture, Cambodia Maharashi Vedic University, Cambodia Department of Animal Health and Production, Cambodia World Vision, Cambodia American Friends Service Committee, Cambodia
Project Budget	$818,743
Project Duration	01/03/2002 to 30/06/2006
ACIAR Research Program Manager	Dr John Skerritt

Project background and objectives

ACIAR manages the Cambodian Agricultural Research Fund (CARF), 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. 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. The fund is providing an environment of competitive tender for agricultural research. In addition to managing the fund itself, the managers arrange both formal and one-on-one training in research problem identification, preparation of research proposals and scientific report writing.

Project progress

Year 2 (01/03/2003-28/02/2004)

For the second funding round, the CARF Panel received 17 proposals submitted by different organizations/institutions. The project leader provided valuable help in mentoring Cambodian scientists developing proposals through two visits to Cambodia prior to the project submission date. The following project applications were successful:

- Identification and development of heat tolerant and multiple disease resistant tomato cultivars for Cambodian farmers (Mr Ouk Makara, CARDI, 3 years)
- Development and dissemination of high yielding and locally adapted maize for sustainable food security in Cambodia (Mrs Sakhan Sophany, CARDI, 3 years)
- Nutrient and crop residue management for sustainable double-cropping on sandy soils under rainfed lowland conditions of Cambodia (Dr Pheav Sovuthy, CARDI, 3 years)
- Research on feed composition for small-scale aquaculture in Kampong Speu Province (Hok Sen Samphea, Royal University of Agriculture, 2 years)
- Assessment of vegetable production potential on Prey Khmer Soil in Kamchai Mear District, Prey Veng Province (Pin Vanarro, Maharashi Vedic University, 1 year)
- The use of cassava leaf silage as a potential protein supplement for cattle in smallholder production in Cambodia (Seng Sokerya, University of Tropical Agriculture, 2 years).

In November 2003, a symposium was held at the Sunway Hotel in Phnom Penh. At this symposium, leaders of current CARF projects gave brief presentations in English on the progress and plans of their project. The symposium had the aims of:

- providing an experience for the project leaders in making a presentation on their project in English,

- raising the profile of CARF in senior Cambodian circles and
- attracting the interest of other donors.

There were 53 attendees, including an opening by the Australian Ambassador and the Secretary of State for Agriculture. In 2004 an internal CARF workshop is planned wherein project staff will discuss results, linkages and data. The meeting could also assist in the writing up of project reports for journal publication.

Steps towards institutionalising CARF have proceeded slower than planned. There is a draft sub-decree establishing a Cambodian Agricultural Research Council in front of the assembly, but with the elections mid-year and the on-going uncertainty about government composition it has not yet been debated.

A formal training course on research problem identification and proposal writing was held for CARF project leaders and selected potential applicants in Phnom Penh from 22-29 January 2003. The course aimed to assist participants in developing and submitting proposals and in publicising the CARF scheme among Cambodian research providers. A joint combination workshop/training exercise was conducted at CARDI during the period 29-31 January 2003. A course on introduction to experimental design and analysis, modern PC-based data handling and statistical methods was held in Phnom Penh (at CARDI) in early November 2003 by staff from the University of Western Australia and Agriculture WA. There were 23 attendees, and all were from institutions involved in CARF projects.

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
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Collaborating Institutions	Directorate General of Fisheries, Indonesia
	Network of Aquaculture Centres in Asia Pacific, Thailand
	Asian Institute of Technology, Thailand
	Aquatic Animal Health Research Institute, Thailand
	James Cook University, Australia
	Queensland Department of Primary Industries and Fisheries, Australia
	Department of Fisheries, Western Australia, Australia
Project Budget	$1,014,019
Project Duration	01/07/2001 to 30/06/2005
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

During the past decade, recurrent disease outbreaks, particularly viral diseases, have caused catastrophic losses in farmed marine prawns throughout the Asia–Pacific region. Consequently many smallholders, who comprise the vast majority of shrimp farmers in Asia, have suffered significant hardship and incurred heavy debts—in many cases causing abandonment of the farm. This situation, together with a general lack of scientifically based disease control and prevention programs, now threatens the survival of the industry in many growing areas. Cost-effective farm-level disease control and prevention programs are essential for reducing losses to acceptable levels, restoring confidence and promoting sustainable development of the industry. In this project scientists are developing and validating farm-level disease control programs for smallholders, demonstrating their effectiveness, and extending them using methods designed to ensure widespread adoption. Targeted are semi-intensive (Indonesia), intensive (Thailand, Australia) and extensive (India) pond production systems.

Project progress

Year 2 (01/07/2002-30/06/2003)

The project has two parts, the 'core project' covering activities in Indonesia, Thailand and Australia, and the 'NACA collaborative component' covering activities in India. The NACA linkage has proved very important to the success of the core project, in that important technical and extension-related information from the Indian work, which began in 2001 under a separate NACA/MPEDA project, has been available one year in advance of similar activities within the core project.

During 2002, project crop failures and equivocal outcomes in Indonesia and Thailand sounded a clear warning of the technical difficulties ahead. In response, at the annual project coordination meeting (Darwin, May 2003), we developed a list of mandatory, non-negotiable program components for implementation on project farms in both countries. To assist full implementation of this 'Darwin protocol', six Indonesian laboratory technicians participated in a PCR methods workshop, held at Mahidol University, Bangkok in September 2003. During the year we also modified some initial principles and assumptions underpinning the project in Asia. Specifically these related to farmer attitudes to maximizing profits; definitions of 'successful' crops; changes to species farmed; and the potential to amplify project impact through linkages with related government programs.

By January 2004, program validation trials in Indonesia and Thailand had been completed in a total of 27 (14 and 13, respectively) ponds. A number of factors, including the round 1 crop failure, limited pond stockings and a changed extension approach contributed to this total being lower than the originally predicted 45-50 ponds. Overall in Indonesia, ten ponds have produced successful crops (four of which were 'major' successes), and four have failed. This represents a success rate of 70%, which is close to the target 80% expected at the beginning of the project. In Thailand, full validation trials were conducted during 2003 only and results differed markedly between provinces.

Project extension activities began their scheduled expansion during 2003. In both Indonesia and Thailand, central and provincial extension teams, with strong links to public and private sector providers, were established. Activities focused on technology transfer to participating key farmers and on demonstrating results, positive and negative, to local farmer groups. Emerging market requirements associated with food safety, trace-ability and certification are placing additional constraints on the small-scale, commercial shrimp farming sector. In this environment, opportunities for important synergies between the project and related programs became apparent during 2003.

In Indonesia, Directorate General Aquaculture intends using the project as a model for wider implementation of shrimp farm biosecurity initiatives, including their 'good aquaculture practice' (GAP) program. In Thailand, the project will promote development of high quality shrimp production 'clusters', with links to relevant government programs. Specific extension plans for all participating countries in 2004-5 were developed at a joint extension workshop.

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 Email: Bglencross@fish.wa.gov.au
Collaborating Institutions	Royal University of Agriculture, Cambodia Can Tho University, Vietnam Research Institute for Aquaculture No. 1, Vietnam Aquaservice, Vietnam Lake Argyle Industries Pty Ltd, Australia
Project Budget	$711,460
Project Duration	01/01/2004 to 30/06/2007
ACIAR Research Program Manager	Dr Geoff Allan

Project background and objectives

Small-scale aquaculture of freshwater species in the Mekong regions of Vietnam and Cambodia is an important source of potential income, constrained by costs associated with feed and feeding. Limited availability of ingredients often results in use of poor quality feed with low nutritional value, which limits production. This project aims to identify prospective feed ingredients based on availability, volume, composition and nutritional quality. Rice bran, plant meals and other potential ingredients are being surveyed for quality and quantity to develop improved diets. Another important objective of the project is to build capacity among nutrition researchers working to develop improved diets, and extension workers working to transfer the information to low-income farmers, to ensure that improvements will continue beyond the project's life.

Project progress

The first progress report is due in early 2005.

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

Overseas Collaborating Countries	Cambodia, Laos, Thailand, Vietnam
Commissioned Organisation	Queensland University of Technology, School of Natural Resource Sciences, Australia
Project Leader	Dr Peter Mather
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	Email: p.mather@qut.edu.au
Collaborating Institutions	Mekong River Commission, Fisheries Programme, Cambodia
	Living Aquatic Resources Research Centre, Laos
	Department of Fisheries, Thailand
	Research Institute for Aquaculture No. 2, Vietnam
Project Budget	$318,785
Project Duration	01/01/2004 to 31/12/2005
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

The fisheries of the Mekong River Basin are essential to the food security of around 60 million people in several countries. Recent efforts by those countries, coordinated through the Mekong River Commission, have seen substantial development in the basin, but development poses a long-term threat to its fisheries. Management of fish stocks is needed, but the complexity and diversity of species (around 1700) requires management based around discrete groups. In this project, molecular genetic techniques are being used to identify gene pools, and hence discrete groups in the various species. Initially this work is focusing on two economically important carp species to demonstrate the approach and build skills in fisheries management.

Project progress

The first progress report is due in early 2005.

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 Email: psaenger@scu.edu.au
Collaborating Institutions	Royal Forest Department, Thailand Vietnam National University, Vietnam
Project Budget	$717,021
Project Duration	01/07/1999 to 30/06/2005 (Project extended from 01/07/2004 to 30/06/2005)
ACIAR Research Program Manager	Mrs Heather Crompton

Project background and objectives

Mangrove communities have been heavily exploited for their wood, and disturbed by other activities including aquaculture, mining, and disposal of chemical wastes. The seeds of most mangroves start to germinate while still attached to the mother tree; replanting to rehabilitate degraded mangrove areas presents difficulties because the survival of gathered mangrove seedlings is generally poor and replacement planting needs to take place over several years. Thus problems of seed collection, seed viability and storage have greatly limited the availability of mangrove germplasm and consequently inhibited genetic studies and the evaluation of different species. 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. It aims to develop the capacity to produce and disseminate high quality mangrove germplasm of known genetic lineage in sufficient quantity to meet replanting needs throughout the region.

Project progress

Outcomes to December 2002

After two and a half years excellent progress had been 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.

FST/1998/096: Domestication of Australian trees for reforestation and agroforestry systems in developing countries

Overseas Collaborating Countries	India, Indonesia, Laos, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Dr John Doran Phone: 02 6281 8319 Email: john.doran@csiro.au
Collaborating Institutions	None
Project Budget	$2,094,461
Project Duration	01/01/2000 to 30/06/2004
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

In much of the developing world people face severe shortages of wood and other forest products. Many Australian tree species are widely grown in developing countries and can help to alleviate this problem. However, failure to use the best germplasm reduces the benefits that these plantations provide. This project builds on earlier ACIAR-funded research and aims to assist developing countries to achieve more effective use of Australian tree species. CSIRO scientists are providing seeds, information and technology to the collaborating countries, and identifying environmental and management factors necessary to improve seed yield and quality. The development of local supply bases of genetically improved seed in collaborating countries will ensure sustainability.

Project progress

Year 4 (01/01/2003-31/12/2003)

As in previous years, seed supply, provision of technical advice and literature, and training continued to be a main focus of the project. Research seedlots with a total weight of 10.5kg valued at $25 000 were sent to a total of 25 customers in 16 countries during the year. During 2003, seed collections to support the project focused on *Eucalyptus camaldulensis*, with extensive field trips to collect natural provenance seed in western Victoria and Queensland. Additionally seed of several species, including *Acacia crassicarpa*, *A. mangium* and *E. pellita*, was collected from seed orchards established in a previous project cycle.

Written technical advice on species and provenance selection, improved seed production, silviculture and utilisation of Australian species was provided by project staff to client organisations in many countries worldwide, with Cambodia, China, Ethiopia, Ghana, India, Indonesia, Kenya, Niger, Rwanda, Tanzania and Thailand prominent.

LWR/1997/150: Salinity management in south-eastern Australia, north-eastern Thailand and Lao PDR

Overseas Collaborating Countries	Laos, Thailand
Commissioned Organisation	University of Technology, National Centre for Groundwater Management, Australia
Project Leader	Dr William Milne-Home
	Phone: 02 9514 1984
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Collaborating Institutions	Ministry of Agriculture and Forestry, Laos
	Khon Kaen University, Thailand
	Land Development Department, Thailand
	Royal Forest Department, Thailand
	Hall Resource Economic Modelling, Australia
Project Budget	$743,496
Project Duration	01/01/2001 to 31/03/2005
	(Project extended from 01/01/2004 to 31/03/2005)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Dryland salinity causes major land degradation and economic loss in Thailand and Australia. Lao PDR currently has only a small area of land affected but there is potential for much larger areas to be affected if they are poorly managed. This project aims to refine and apply groundwater mapping and modelling technologies to describe recharge and discharge processes in selected catchments of northeast Thailand, central Laos and southeast Australia. The scientists are examining the relative effect of trees in plantations and other configurations in comparison with alternative land uses on groundwater recharge and discharge. This will help to predict the local and regional impact of current and proposed reforestation projects on groundwater hydrology of the selected catchments. In addition, an economic study is being conducted to highlight the social and economic consequences of the hydrological impacts associated with various reforestation scenarios, and of the increased use of saline groundwater resources within the cultural context of each country.

Project progress

Year 3 (01/01/2003-31/12/2003)

The Savannakhet monitoring program continued, with loggers recording daily groundwater levels in project piezometers. Seasonal water samples were collected. Temperature, pH, EC, and Salinity were recorded in the field before ion analysis in the Vientiane Lab. The water level and quality data is now under analysis.

Geological records have been collected from the Phou Doi water supply project in Xeno, and Phailom drilling. These records were combined and entered into 'Rockworks' software for modelling as a 3D geological model.

Conductivity values were computed from soil samples obtained during piezometer drilling. Meteorological data was collected from Savannakhet, Kengkok, Xeno and surrounding villages, including daily rainfall, evaporation, and humidity information. Flood height records were collected for 2001-03, along with river discharge for the three major tributaries in the study area. Construction records were obtained for irrigation reservoirs in the area, including proposed sizes and completion.

Analysis of all available hydrogeological data has been done and a hydrogeological database for the study area for 2001-03 established. Geological cross-sections and fence diagrams and seasonal groundwater contour maps have been developed along with a hydrogeological conceptual model (flow and salinity mobilisation).

Tree clearing and plantation records were obtained from the Lao Forestry Department. An analysis of a GIS database, allowed preparation of maps to identify salinity risk areas. GIS maps for the Mekong plain including: geology, land use/forest cover, irrigation infrastructure (existing and proposed), and soil classification are available along with a salinity risk areas map—based on GIS data.

An artesian bore at Ban Bu Rawai was capped to halt discharging saline water. Socio economic surveys in Khorat and Kalasin were completed, with data summarised into modelling units and transferred to HREM for modelling.

A Spatial optimisation Model for Analysing Catchment Management (SMAC) model adaptation for Thailand was completed, with a new model named Isaan Catchment Hydrological and Agricultural Model established. Hydrogeological models using Visual MODFLOW have been built for the study areas.

Tree water use (TWU) measurements were completed on eucalypt, acacia ampliceps, and neem trees. The TWU data collated from the project's duration was converted into Excel spreadsheets in preparation for the final project database. Statistical analysis of Thai TWU data similar to Australian was data carried out in 2001-02. A SMAC model was adapted to the Upper Macquarie Valley and developed to include an agroforestry component.

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

Overseas Collaborating Countries	Thailand, Vietnam
Commissioned Organisation	CSIRO Land and Water, Australia
Project Leader	Dr Mike McLaughlin
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Collaborating Institutions	Asian Vegetable Research and Development Center, Taiwan
	Department of Agriculture, Thailand
	Department of Land Development, Thailand
	University of Agriculture and Forestry, Vietnam
	National Institute for Soils and Fertilisers, Vietnam
	Queensland Department of Primary Industries and Fisheries, Australia
	Department of Natural Resources and Mines, Queensland, Australia
Project Budget	$1,012,730
Project Duration	01/07/2001 to 30/06/2005
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Earlier ACIAR-supported research revealed that in parts of Asia peri-urban areas used for crops such as rice, potatoes and peanuts are at risk of metal contamination. Contamination by metals has health implications but the more immediate economic impacts arise from non-tariff trade barriers related to product quality. This project is directed at the growing concern regarding the contamination of soils and crops in Southeast Asia. It is developing research capacity and laboratory facilities for the study of soil and crop contamination in Vietnam and establishing training and exchange programs for staff in all the collaborating countries. Scientists are determining maximum allowable concentrations of contaminants in soils of the region, based on their studies of the re-use of wastes on agricultural soils, contamination of produce and of the ecotoxic effects of contaminants on soil microbial processes. They are developing criteria to assess the suitability of different wastes and composts for re-use on soils, based on experimentation examining a wide range of industrial and urban wastes commonly used in peri-urban and intensive agriculture. The research includes strategies to minimise adverse impacts of contaminants in agricultural inputs to soils in these sensitive areas.

Project progress

Year 2 (01/07/2002-30/06/2003)

Personnel have been trained for laboratory and field operations of the project in Hanoi and Ho Chi Minh City. Two of the initial trainees have accepted offers to undertake postgraduate studies in Australia and Thailand. Their roles in the project will be taken over by staff who have had limited training in Australia, but have been trained thoroughly by the Vietnamese staff leaving the project. The project team is also planning to modify the project's initial plan and send Gillian Cozens back to Vietnam and Thailand to implement additional training. This training is intended to further develop analytical skills for the replacement staff and assist with data interpretation. Metal dose response analysis will be carried out by using a Microsoft Excel-based EC50 calculator, which has been developed in Adelaide as an alternative to the complex data analysis required for assessing and comparing toxic responses.

Baseline data for the concentrations of toxic metals in soils of Vietnam are 90% complete. Critical loads for metals (copper, zinc and cadmium) have been determined at the laboratory scale at all sites in Thailand, Vietnam and Australia, and are now being verified with field

trials. All together, eight field sites have been established in Southeast Asia and 14 in Australia. All ACIAR-funded sites have been established in Australia in addition to two National Biosolids Research Program sites in Victoria, to finalise the field site network of 16 in Australia. These field sites are ongoing, with 90% of the analysis done for the first season and many field sites currently in their second season of crop growth.

Metal concentrations in organic/green wastes and biosolids have been determined and field experiments are ongoing for the assessment of beneficial and detrimental effects from these wastes. Scientific criteria will be used to complete a preliminary ranking to determine whether wastes are suitable or unsuitable for continued use in intensive peri-urban agricultural systems, once data from the first two crops from field trials are analysed statistically.

Communication has involved keeping the appropriate government bodies informed of the aims and progress of the research program—directly (e.g. by inviting personnel to workshops and through personal communications) and indirectly (through publication in journals). Key scientists in each country have identified and fostered relationships with the appropriate government bodies to ensure the correct communication channels will be available when the data from the project are statistically analysed, baseline data and metal thresholds determined, and appropriate guideline values derived. Local growers at all sites have been interested in the field trials, but as yet no farmer field days have been conducted in Southeast Asia.

LWR/1998/124: Development of technologies to alleviate soil acidification in legume-based production systems in the tropics of Asia and Australia

Overseas Collaborating Countries	China, Thailand
Commissioned Organisation	CSIRO Land and Water, Davis Laboratory, Australia
Project Leader	Ms Suzanne Berthelsen
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Collaborating Institutions	Chinese Academy of Tropical Agricultural Science, China
	Khon Kaen University, Thailand
	Queensland Department of Natural Resources and Mines, Australia
Project Budget	$712,810
Project Duration	01/07/2000 to 30/06/2005
	(Project extended from 01/07/2004 to 30/06/2005)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Because of their capacity to fix atmospheric nitrogen and break down into organic matter in the soil, legumes are commonly used in farming systems to improve soil fertility. Yet increasing use of legumes with inappropriate management practices can lead to the problems of soil acidity, and soils with a high degree of acidification show poor fertility and low pH buffering capacity that result in low productivity. The project aims to reverse the negative impacts of accelerated acidification and nutrient depletion through the development of new methods to prevent or limit these processes.

Project progress

Year 3 (01/07/2002-30/06/2003)

In Thailand, the 'paired sites' have been developed into a risk assessment map for predicting the potential rates of acidification under current land use systems. This has resulted in the development of a map that predicts the number of years until pH decreases to a level considered unproductive. Results of paired sites on soil degradation have been widely publicised and are in the process of integration into provincial development plans for soil and land resource rehabilitation. The concept of deep-rooted species on degraded soil rehabilitation is widely accepted by 16 farmer network all over the northeast of Thailand, and it is on the process of community research for agricultural resource development within the networks using the budget from Thailand Research Fund (TRF). Interactions between researchers and farmers in Participatory Research was revealed as an effective means of spreading, not only the results of this project, but techniques of research and the dissemination of other potential improvements to productivity and sustainability at the farm enterprise level. Thailand's Organic Farming Network is adopting clay technology for reduction of volatilized loss of ammonia from chicken manure compost both for during composting and post-application in organic farms. Farmers are appreciating the concept that alkalinity is exported in the crop, and its subsequent effect on soil acidification.

In China, the effects of management practices in reducing the dominance of legumes in pasture and thus reducing the potential for enhanced rates of acidification have been revealed, along with the potential to use the acidification buffering capacity of soils to develop a model for determining resources required to rejuvenate less productive lands. The design of field trials that will couple, for the first time, the benefits of using high-activity clay technologies with nitrate-based fertiliser schedules with deep rooted grass species to address the best combinations of technologies to alleviate and reverse soil acidification was shown.

A demonstration of the benefits of clays with high nutrient-holding capacity in enhancing productivity of grasses was undertaken in Thailand and Australia. The ability of nitrate-based nitrogen fertilisers to reverse acidification; in Australia to a depth of 90cm, was proven.

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
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Collaborating Institutions	Cambodia Agricultural Research and Development Institute, Cambodia
	Department of Agriculture, Western Australia, Australia
Project Budget	$766,290
Project Duration	01/01/2003 to 31/12/2005
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

In recent years Cambodia has achieved self-sufficiency in rice production. Now opportunities to alleviate poverty through investment in Cambodian agriculture are emerging, involving diversification from traditional lowland rice production to alternative rice production systems and to upland crops. Crop diversification has potential to increase profitability for farmers. However, there are risks for individual farmers associated with adopting these changes in agricultural systems, and uncertainty for government agencies about where effort and resources should be directed to facilitate change. This project aims to increase adoption of crop diversification in Cambodia and southern Australia. In Cambodia, the project is assessing land suitability for non-rice crops in double-cropped rice-based systems and for upland crops. The project is also assessing agricultural areas of Western Australia to predict land suitability for pulse cropping under a range of production scenarios.

Project progress

Year 1 (01/01/2003-31/12/2003)

In Cambodia, the first 12 months work has involved the selection of study areas—in each of the three provinces a district was selected for detailed study. Districts were selected to represent the range of soils, and both upland and lowland agro-ecosystems of the province. Districts cover an area small enough for detailed and semi-detailed studies. Study areas selected are as follows: Kampong Cham- Ou Riang Ov district in the south east of the province; Takeo- Tramkak district on the western margin of the province; Batdambang – Banan district, south of the provincial centre.

In each of the study districts, 50 farmer house-holds were interviewed to elicit their experience and knowledge about crop diversification. Results have been entered in an Access database for analysis.

Detailed soil profile descriptions were made at 23 sites in Takeo and Kampong Cham, including locations of on-farm field crop assessments. The WA Department of Agriculture database was modified to record soil profile information. The FAO World Reference base was used as the system for coding and recording soil properties. The data has been entered in the database, as has additional soil profile records from Cambodia. The aim of this work is to develop a standardised internationally linked system for the establishment of a soil database for Cambodia. An earlier Vietnamese soil survey in Takeo (1:50,000) was considered to be accurate and a sound basis for mapping soils in this project in Takeo province. By contrast, there is no equivalent detailed soils map to use on uplands in Kampong Cham province. Soil mapping will be based on field surveying, topography maps, digital terrain models and agro-ecosystem analysis conducted at commune level by the Provincial Department of Agricultural Extension and the Cambodia Australia Agricultural Extension Project. Field work was carried out in June 2003, and a draft soil map for the district completed in November 2003.

On-farm trials were conducted to establish a benchmark for yield potential in different crops and how these would vary across soils in a particular district. Eight were sown in Tramkak in June (the early wet season) and 8 in Ou Riang Ov in July-August (main wet season). Crops sown were: mung bean, sweet corn, maize, sesame, soybean, peanut, and chilli. In the sandy soils of Tramkak, establishment and early growth of peanut and maize was most promising, whereas soybean and mung bean were poor. These trials emphasised the need to acquire improved cultivars and improved seed quality, both of which will be pursued in collaboration with Bob Martin's ACIAR Project.

A preliminary analysis of rainfall data from the provinces of Kampong Cham, Takeo and Batdambang was carried based on records supplied by the Mekong River Commission. This suggests that total rainfall is less than some previous publications have suggested for Cambodia and increases concerns about early wet season drought as a limiting factor for field crops. A preliminary list of limiting factors for each of the main soils types for field crops has been prepared and discussed at the Project meeting in September 2003.

In Australia, the initial work has involved defining soil and landscape requirements by pulse experts for field pea, chickpea, faba bean and lentil. The characteristics rated were:

- flood hazard, pH at 0-10 cm,
- pH at 50-80 cm, salinity hazard,
- surface salinity,
- salt spray exposure,
- surface condition,
- surface soil structure decline susceptibility,
- surface stones and gravels,
- subsurface acidification susceptibility,
- subsurface compaction susceptibility,
- trafficability,
- rooting depth,
- waterlogging/inundation risk,
- water repellence susceptibility,
- soil water storage,
- wind erosion risk, and
- soil workability.

Ratings for each characteristic were based on experimental data or agronomists' expert opinion. These were then used in conjunction with the Department of Agricultures soils and soil attributes database and GIS to map land capability at regional scale for these pulses. Initial ratings for water logging, stoniness, wind erosion risk and water repellence for field pea were revised to generate land capability maps that were reasonable reflections of expert knowledge. The results so far provide a more comprehensive assessment of land capability for pulses than previously compiled maps. The field trial data sets for pulses in WA comprising 105 experiments were compiled for use in the Expector modelling later.

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

Overseas Collaborating Countries	Malaysia, Philippines, Thailand, Vietnam
Commissioned Organisation	International Plant Genetic Resources Institute, Malaysia
Project Leader	Dr V. Ramanatha Rao Phone: + 60 3 89423891 Email: v.rao@cgiar.org
Collaborating Institutions	Universiti Kebangsaan Malaysia, Malaysia University of the Philippines at Los Banõs, Philippines Department of Agriculture, Thailand Institute of Agricultural Genetics, Vietnam Griffith University, Australia
Project Budget	$746,479
Project Duration	01/01/2003 to 31/12/2005
ACIAR Research Program Manager	Dr Colin Piggin

Project background and objectives

Conservation of many tropical fruit species is often difficult or impossible by traditional methods as many species have recalcitrant seeds (they do not tolerate drying and so cannot be stored in the standard way). Other species may have no natural seed dormancy, their seeds may have only a short life span, or they may not produce any seeds. Conservation of genetic resources of these species is extremely important but efficient and appropriate methods for their long-term and sustainable conservation are not available. This project is developing new techniques to conserve the germplasm of selected tropical fruits and related species. The major objectives of the project are to develop cryopreservation methods (storage at ultra-low temperatures) for priority species, to develop alternative conservation and regeneration strategies, and to disseminate proven technologies to researchers and other users in the region.

Project progress

Year 3 (01/01/2003-31/12/2003)

The outputs expected for all three objectives in year 1 were fully achieved. The five partner countries are working on identified priority tropical fruits to develop new techniques to conserve germplasm. The initial stages of the project involved developing micropropagation systems for the identified crops (mango, papaya, Australian native fruits, *Nephelium*, citrus, persimmon, litchi and longan). Successful tissue culture systems were established to provide plant material for cryopreservation work.

Cryopreservation techniques such as encapsulation dehydration, vitrification, new encapsulation-dehydration and slow freezing were attempted to conserve different plant materials. Developing-country partners were trained in using these techniques through a course organised at Griffith University, Australia in September, 2003. At the end of the course, each trainee developed a re-entry plan in line with project activities, to be implemented upon return to their institutions. Initial work on cryopreservation of papaya, citrus, Australian native fruits (citrus and Davidson plum) showed promising results. Work on mango, persimmon, litchi and longan has progressed well in establishing micropropagation systems. Alternative conservation strategies such as slow growth as well as storage of seed in liquid nitrogen were attempted. Positive results were obtained for papaya and citrus. Established micropropagation techniques were shared among partner countries working on the same crop to adapt to the different species that they are working on.

CIM/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
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Collaborating Institutions	Khon Kaen University, Thailand
	Cuu Long Rice Research Institute, Vietnam
	Curtin University of Technology, Australia
Project Budget	$496,764
Project Duration	01/01/2004 to 30/06/2007
ACIAR Research Program Manager	Dr Colin Piggin

Project background and objectives

Migration of men from rural to urban areas in search of employment is common in many developing countries. Many smallholders rely on income from family members engaged in off-farm work. The impacts of migration on the balance between reduced productivity from labour losses and increased off-farm income compensating through increased purchases of inputs is unclear, especially impacts on women. By examining rice-based farming systems in Vietnam and Thailand, and various farming systems in Australia, the project aims to increase understanding of changes in rural agriculture resulting from migration, particularly the changing roles of, and constraints on, women running farms. This understanding will inform the development of strategies and policy options to address constraints to productivity, for dissemination to key stakeholders.

Project progress

The first progress report is due in early 2005

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
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Collaborating Institutions	Bogor Agricultural University, Indonesia
	Lampung University, Indonesia
	Forest and Nature Conservation Research and Development Centre, Indonesia
	Center for Soil and Agroclimate Research, Indonesia
	Brawijaya University, Indonesia
	National University of Singapore, Singapore
	Chiang Mai University, Thailand
	Australian National University, Australia
	CSIRO Land and Water, Australia
Project Budget	$1,142,952
Project Duration	01/07/2002 to 30/06/2006
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

In many developing countries scarcity of land has produced a steady migration of settlers to farm forested uplands. These settlers have come into serious conflict with downstream water users (irrigation, industry and urban) because of real or perceived impressions of lower quality water and reduced flows from catchments. The response of most governments has been to restrict agriculture in critical catchments and/or to evict farmers, at considerable economic and social cost. The aims of this project are to characterise current land-use, look for trends in land-use change in selected watersheds, and determine how changes (including seasonal changes) affect filter functions and impact on water quantity and sediment load. The scientists are testing the effectiveness of existing filter elements, incorporating the data into spatially explicit models of soil and water movements in landscape mosaics at catchment scale, and quantifying the trade-off between watershed functions and profitability of land-use for current and possible future land-use mosaics. There is also some participatory exploration of alternative practices.

Project progress

Year 1 (01/07/2002-30/06/2003)

In the first year the project team made substantial progress towards each of the three project goals for the major research sites in Sumberjaya (Lampung, Indonesia) and Mae Chaem (northern Thailand).

Analysis of historical records of rainfall and river flow revealed a) the differences and similarities between the two study catchments, and b) the relative importance of changes in tree cover for total water yield (especially at 1.5 m of rain per annum in northern Thailand) and of changes in soil properties for the quick flow component (especially at 2.5 m of rain per annum in Lampung). To bridge between plot-level data and landscape level effects, a spatially explicit rainfall simulator proved to be an essential tool. Analysis of available data showed the low spatial correlation in rainfall events in the Sumberjaya watershed if distances between recording stations are larger than 2–3 km.

Uncertainty on total input of rainfall is a major constraint to the validation of models with the scarce data sets available. Project members have to rely on a comparison of statistical distributions, rather than event-level correspondence between observed and predicted flows. Quantitative tests of the models for both catchments show satisfactory correspondence on

indicators of total water yield, buffering of flow and dry-season flows. The land use change in the period 1975 (still 60% forest) to 2000 (15% forest) in Sumberjaya has increased the total water yield per unit rainfall (from 45 to 70%) as well as the number of days that the target water flow for the hydroelectric facility can be met. A new 'buffer indicator' that relates peak flows to peak rain events showed a parallel shift, but there was no consistent change in either the river volume in the driest month or the maximum daily flow.

Equipment was obtained and installed to monitor sediment loads of the river in two subcatchments of Sumberjaya. Initial results of monitoring water quality identified limited problems with sediment loads but valid concerns about pesticide levels linked to pockets of intensive horticulture, in both Mae Chaem and Sumberjaya. A lot of the riparian vegetation just next to the river—albeit often a very narrow strip—is still intact, stimulating biological life. Model analysis suggested that the riparian zone forest has a more-than-proportionately positive impact on reducing sediment loads of the river, provided that there are no 'break-through' points where footpaths, motorbike trails or roads intercept streams and rivers.

The first agreements were signed between local government and farmer groups in Sumberjaya under the 'community forest management' umbrella to allow multistrata coffee gardens to be maintained within the 'protection forest' zone, provided watershed functions are maintained. The project research contributes to the development of criteria and indicators for such agreements and the way they can be monitored.

With the low current prices of coffee the profitability of coffee-based systems has dropped to a level that the opportunity cost of labour is too high for intensive management. Mixed tree-based systems are superior to intensive coffee monocultures when long-term price estimates are used. With improved road access to the area the option of intensive horticulture is gaining popularity, although it only covers a small fraction of the land in Sumberjaya so far. By contrast intensive horticulture is a major source of income in the Mae Chaem watershed, especially by the Hmong farmers using the ridge tops. Its impact on the soil and on infiltration, as well as on river flow due to dry-season irrigation, is a major reason for concern.

Concluded projects

1 July 2002–30 June 2004

AS1/1994/038: Improved diagnostic and control methodologies for livestock diseases in Lao PDR and Yunnan Province, PRC

Overseas Collaborating Countries:	China, Laos
Commissioned Organisation	CSIRO Australian Animal Health Laboratory, Australia
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Collaborating Institutions	Yunnan Veterinary General Station, China
	Department of Livestock and Fisheries, Laos
	Australian Volunteers International, Australia
Project Budget	$790,936
Project Duration	01/01/1997 to 30/06/2003
	(Project extended from 01/01/2002 to 30/06/2003)
ACIAR Research Program Manager	Dr John Copland

Project background and objectives

Lao PDR is a natural corridor through which livestock travel between markets in southern China, Vietnam, Cambodia and Thailand. Most of the country's 4.5 million people are involved in subsistence farming; livestock raising is their main source of cash income and contributes 40% of Lao PDR's agricultural gross domestic product.

The Department of Livestock and Fisheries in Lao PDR had set up a four-tiered network of veterinary workers – at village, district, province and national levels - but the network was under-resourced, lacking skills and equipment. As a result, no detailed information was available about the frequent outbreaks of disease in buffalo, cattle, chickens and pigs, and there were no effective national control and surveillance programs. This reduced the nation's prosperity and also raised international concern about through-traffic of stock and animal products.

This project, the first ACIAR Animal Science project in Lao PDR, had the major involvement of an Australian volunteer (Australian Volunteers International, AVI) based at Vientiane. It focused on foot-and-mouth disease virus (FMDV) in ruminants and pigs, and classical swine fever virus (CSFV). Both these highly contagious diseases spread readily and caused concern in Yunnan Province, China, where the established veterinary network lacked the techniques to detect specific viruses and their antibodies.

This study aimed to improve staff skills in disease surveillance, diagnosis, epidemiology and laboratory technology. The DLF would then be able to set up immunisation programs, monitor their effectiveness, assess the significance of particular diseases, and develop animal health information systems.

Project outcomes

The project established a functional field investigation network and an operational virology laboratory in Lao PDR, both of which were major benefits to the country. Three ELISA tests for FMDV and two for CSFV were established and significant progress was made in establishing the epidemiological characteristics of FMD and CSF. Two out of three pig breed susceptibility studies were completed. Molecular epidemiological studies were commenced in Lao PDR and at AAHL/CSIRO in Australia.

The laboratory became the main player in an attempt to control an outbreak of FMD in southern Laos. At the request of the Laotian Government, AusAID made funds available, through ACIAR, for the purchase of half a million doses of FMD vaccine. The researchers diagnosed the particular strain of the FMD virus responsible for the outbreak, identified and ordered the appropriate vaccine, and commenced the development of a control strategy.

In China all five ELISA tests for FMD and CSF were established. Of these three are in routine use, complementing existing tests. The lasting impacts of the project were considered to be the increased capacity for diagnosis of FMD and CSF in Lao and the strengthening of the diagnostic institutional structure of the Yunnan Tropical and Sub Tropical Animal Virus Laboratory at Kunming.

The review team believed that the success of the project was due to the strong commitment of all project scientists and in particular the AVI scientist. The project had strong support from all levels of government in all countries as well as developing strong linkages to the International Atomic Energy Agency, FAO and the South East Asian FMD campaign of the Office International des Epizooties. Regular meetings between Laos and China (Kunming) on their common border have led to the establishment by Kunming of a border post to monitor live animal movements and test for specific diseases.

Australia benefited from the development of additional diagnostic tests to FMD and CSF. Some work still to be completed was transferred to a new ACIAR medium project, *AS1/2003/001 Management of CSF and FMD at the village level in Lao PDR*.

AS1/1996/160: Control of fasciolosis in cattle and buffaloes in Indonesia, Philippines and Cambodia

Overseas Collaborating Countries:	Cambodia, Indonesia, Philippines
Commissioned Organisation	James Cook University, The Australian Institute of Tropical Veterinary and Animal Science,, Australia
Project Leader	Dr Richard Copland
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Collaborating Institutions	National Veterinary Diagnostic Laboratory, Cambodia
	Research Institute for Veterinary Science, Indonesia
	Central Mindanao University, Philippines
	University of Southern Mindanao, Philippines
Project Budget	$1,048,341
Project Duration	01/07/1998 to 31/12/2003
	(Project extended from 01/07/2003 to 31/12/2003)
ACIAR Research Program Manager	Dr John Copland

Project background and objectives

Fasciolosis caused by infection with the liver fluke, *Fasciola gigantica*, is an important disease of cattle and buffaloes in Southeast Asia. This project validated and extended the successful control strategies developed in Indonesia (Project AS1/1999/023) to control liver fluke in Indonesia, Cambodia and the Philippines. The scientists tested the biological control of fasciolosis by using poultry infected with *Echinostoma revolutum,* as *E. revolutum* and *F. gigantica* compete for the same snail as an intermediate host. They also determined the resistance of cattle and buffaloes to fasciolosis and establish a fascioloa control network throughout Southeast Asia.

Project outcomes

All of the objectives of the project have been achieved, although extra time may be needed to complete some elements of the project, and for analysis and publication of the results. The overall output of this project has been to demonstrate in the areas involved in the field experiments that the application of a scientifically based fasciolosis control program will alleviate poverty through increased animal production. The wider application (and benefits) of the results of this project will require the publication and dissemination of results, and the institutionalisation of the extension program by the collaborating countries.

The community impact has been to educate animal owners who participated in the research and increase their income from animal production. The project also produced a major impact on the capacity of researchers to successfully carry out experimental work. All of the researchers from Asian countries now have English as a second language. As well, some researchers are better skilled in analysing experimental results. The development of language, writing and analytical skills among the research team will be one of the most significant and long-lasting achievements of this project.

AS1/1998/036: Management of rodent pests in rice-based farming systems

Overseas Collaborating Countries:	Indonesia, Laos, Malaysia, Vietnam
Commissioned Organisation	CSIRO Sustainable Ecosystems, Australia
Project Leader	Dr Grant Singleton
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Collaborating Institutions	Department of Agriculture and Extension, Laos
	Central Research Institute for Food Crops, Indonesia
	Universiti Putra Malaysia, Malaysia
	National Institute of Plant Protection, Vietnam
Project Budget	$1,080,606
Project Duration	01/01/1999 to 30/06/2003
	(Project extended from 31/12/2002 to 30/06/2003)
ACIAR Research Program Manager	Dr John Copland

Project background and objectives

Losses of the rice crop in Southeast Asia due to rodents can be close to 20 per cent of production, and many farmers feel they have little capacity for rodent control. Earlier ACIAR projects discovered a great deal about rodent feeding and breeding habits and developed an effective control method, based on an early 'trap crop' that captures many animals prior to the ripening of the main crop. In this project scientists undertook further development of an integrated rodent control system, initially at village level then moving to district level. They also investigated prospects for fertility control of rodents through bait delivery of an infertility agent. Project members developed and maintained a 'Rodent Pest Information Network' and contributed to scientist training in Laos, Indonesia and Vietnam.

Project outcomes

In Indonesia and Vietnam, integrated ecologically-based rodent management was applied by farmers at a village level (70-100 ha) at two sites and normal management practices applied at two untreated sites for 2.5 years. The integrated management methods included:

- promotion of synchrony of cropping (crops planted within 2 weeks of each other)
- the use of a community trap-barrier system (CTBS),
- short two-week campaigns to collect rodents at key times (1 week prior to transplanting; or within 2 weeks of crop initiation) and in focal (source) habitats,
- where possible to reduce width of irrigation banks to less than 30 cm,
- increase general hygiene around villages and village gardens.

The implementation and testing of integrated rodent pest management was based on a solid understanding of the population ecology of the pest species and of the farming systems, together with strong farmer participation. For example, in Vietnam, radio-tracking and monthly live-trapping indicated that rats used banks of major and smaller irrigation channels during the non-breeding season (tillering stage of rice) and used rice fields during the breeding season (ripening stage of rice). In Indonesia, monthly monitoring of rodent populations across five habitats highlighted that rats aggregated along main channel banks and in village gardens during land preparation. Farmers used this information to develop community-based rat drives along channel banks and around villages during the week prior to transplanting the rice crop or the two weeks after planting.

The integrated approach to rodent management provided strong economic, environmental and policy impacts.

- *Economic impacts*: In Indonesia, there were consistent increases in rice yield (range 0.1 to 0.9 t/ha). In Vietnam, rodent densities were consistently low, however, there

was marginally less rodent damage in the treated villages compared to the control villages.

- *Environmental impacts*: There was marked reduction in chemical usage by farmers in the treatment villages. In Indonesia, at the beginning of the study 98% of farmers used chemicals to control rats across all sites. Often these were highly toxic chemicals mixed with oil and then added to the irrigation water. Two years later chemical usage had dropped to 46% of farmers in the treatment villages (with no oil "cocktails") compared to 88% of farmers in the untreated villages. In Vietnam, all farmers used chemicals across all sites. In the final year of the study, chemical usage had dropped to 4% of farmers in the treatment villages compared to 68% in the untreated villages. There was also a large reduction in farmers using plastic barriers around their crops in the treated villages (70% to 11%), whereas there was little change in the untreated villages (70% to 77%).
- *Policy impacts*: In Indonesia, an integrated 'National Rodent Management Program' (Gama Pamati) was developed in 2001 based on recommendations arising from collaborative work funded by ACIAR in West Java. This program now forms the basis for the national policy on rodent pest management in Indonesia.

In Laos, 10 research and extension staff from five provinces were trained at various times in the principles of rodent ecology and management. Projects were established in four upland provinces where data were collected on the history of rodent outbreaks, on breeding and species composition of the rodents, and on the effectiveness of a trap-barrier system (TBS) in the upland habitats. The TBS technology had limited impact in the fields in the upland shifting cultivation systems; however, farmers adapted the technology to protect their valuable grain stores from rats. A volunteer working with the project provided a high quality appraisal of the post-harvest impact of rodents in five upland villages, an assessment of different designs of grain stores and a detailed appraisal of the rodent fauna in forest habitats at one study site.

The first rodent taxonomic key was developed for all the significant rodent pest species and common non-pest rodent species in Southeast Asia. The key plus species distribution maps, photos of key physical features and a brief description of the biology of each species were published in ACIAR Monograph 100, *Field methods for rodent studies in Asia and the Indo-Pacific* (K P Aplin, P R Brown, J Jacob, C J Krebs & G R Singleton, 2003).

Australian studies of the field ecology of mouse populations have provided a better understanding of the key factors that influence eruptions of mouse plagues. The rate of change of populations during the breeding season is independent of density effects, but if the population density is high at the commencement of breeding then the litter size is depressed throughout that breeding season. There are density-dependent effects on survival during the non-breeding season. Moreover, rates of increase of populations over spring and summer are highly correlated with accumulated rainfall from the previous winter-spring (April-October). These findings have led to:

a) A refinement of a model for forecasting plagues that has been used successfully in Victoria for the past three years.
b) Development of a model on fertility control of mice that indicates that sterilising just one third of all female mice for the entire breeding season is sufficient to prevent mouse plagues. This detailed analysis of seasonal population dynamics has established specifications for the use of fertility control of mice that appear quite achievable.

The project had significant capacity-building outcomes, with 18 students undertaking research based on the project as part of their Honours or higher degree studies.

ASEM/2001/095: Institutional strengthening for integrated water resource management in Thailand

Overseas Collaborating Countries:	Thailand
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Collaborating Institutions	Royal Project Foundation, Thailand
Project Budget	$287,778
Project Duration	01/04/2002 to 30/06/2004
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

In Thailand, over-exploitation and nonsustainable use of available land, water and vegetation resources is causing loss of forest cover and biodiversity, soil erosion and deteriorating water quality, particularly in the north of the country. Sustainable development requires land and vegetation management to be integrated with effects on ecosystems, land and water, and the local communities and cultures that depend on those resources. However, there are currently few technical tools to support such integrated management.

In a previous project, researchers developed an integrated water resources assessment and management (IWRAM) framework. A set of linked models, accessed through a computer-based decision support system, allows users to explore the impacts of policy, planning and regulatory options on aspects such as soil erosion, water availability and the socioeconomic conditions of households and communities. IWRAM has been successfully trialled in the Mae Chaem catchment in northern Thailand. The current project aims to improve the model and increase its uptake by relevant agencies.

A previous project developed a computer-based modelling and decision support system for assessing how different development options might impact on land and water resources. The aim of this project is to make the technology more robust, to increase awareness of its capacity and applications, and to integrate it into routine use by various agencies in Thailand.

Project outcomes

The robustness of the IWRAM (integrated water resources assessment and management) approach was established by the Thai team in an earlier ACIAR project. The purpose of this project was to complete the hand-over of the underlying IWRAM tools and support the Thai team in building their capacity to implement and extend the approach, with:

- the Thai team re-implementing the underlying models to suit the level of expertise available within their departments and agencies
- the Thai team actively engaged in extension of IWRAM to the rest of Thailand and neighbouring regions through national research projects
- the Thai team ready to conduct their own training workshop in IWRAM principles, using their IWRAM-Decision Support System (DSS) as the training tool
- the development of the IWRAM website as a communications tool for team members and the public

Key outputs are suitable reference and training materials, and the Thai version of the IWRAM-DSS. The major Thai product has been a book describing Phase 1 of the project compiled and produced by the Royal Project Foundation. This book is in Thai with much of the content derived from material provided by the Australian team. The development of the IWRAM website has been a key output and its evolution reflects the developing ownership of the Thai team of the material and framework. This has been matched by the developing confidence of the Thai team to run training workshops for their colleagues and counterparts in other countries in the region. A key activity for the Thai researchers has been the re-implementation

of the IWRAM-DSS as an integration tool for training in the principles of integrated assessment. This DSS has been piloted for the project case study in the Mae Kuang basin.

The building of a trans-disciplinary approach to modelling interactions in catchments has drawn together researchers and practitioners from many disciplines and agencies, and has aligned well with a national initiative to implement integrated catchment management. The project has provided for the building of strong linkages between government departments responsible for natural resource management, especially water, and socio-economic research being undertaken in universities.

Within the natural resource management sphere agency professionals have a greater understanding, crucial in convincing policy makers to legislate for, and farmers to implement, sustainable land use and natural resources management. The researchers play a key role in informing extension officers on the suitability of crops and management practices.

A major aim of the Royal Project Foundation through the activities of this project has been to identify crops and cropping practices that raise the standard of living for local farmers, especially hill tribes, while conserving the environment, and anticipating future demands on water supply. The extensive catchment activity associated with the project (field trips, surveys) have provided strong positive signals to the local communities that they are valued by the Royal Project Foundation, and the government.

At the regional scale, the development of expertise at whole-of-catchment assessment, using a range of social, economic and biophysical indicators, gives the Thai team the ability to play a key role in the region in the development of bilateral and trans-boundary water and land management issues. They intend to use this expertise to work with their regional neighbours to develop sustainable use of their watersheds. At the local scale, the development of the IWRAM-DSS means that researchers will be providing extension officers and farmers with farming ‘solutions’ that are better for the environment without compromising economic return.

FIS/1996/098: Diagnostic tests and epidemiological probes for prawn viruses in Thailand and Australia

Overseas Collaborating Countries:	Thailand
Commissioned Organisation	CSIRO Livestock Industries, Australia
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Collaborating Institutions	Mahidol University, Thailand
	Network of Aquaculture Centres in Asia Pacific, Thailand
	Department of Fisheries, Thailand
	James Cook University, Australia
	CSIRO Animal Health, Australia
Project Budget	$742,710
Project Duration	01/07/1998 to 30/09/2003
	(Project extended from 01/07/2001 to 30/09/2003)
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

The prawn/shrimp culture industry, based primarily in low-income food-deficient countries of Asia and Latin America, yields an annual harvest of around 4 million tonnes. It has contributed significantly to food security, employment and socioeconomic development in poor rural communities.

Thailand is one of the world's largest producers but, as elsewhere in Asia, most production comes from smallholder farmers with limited capacity to control important production factors such as quality of seed prawns, feed and pond water. Disease is a huge problem particularly in Asia, with losses caused mainly by two viral diseases – yellow head virus (YHV) and white spot syndrome virus (WSSV). Both of these diseases are exotic to Australia but a yellow-head-like virus (gill-associated virus or GAV) is known to affect Australian cultured prawns.

The development of diagnostic and detection capabilities and increased knowledge of distribution, prevalence, variability and epidemiology of the diseases are key factors in developing effective control measures. This project focused on the increase in scientific knowledge and development of technologies to increase diagnostic capabilities in Thailand and Australia, with an expected flow-on throughout the region.

The project aimed to improve diagnostic capabilities for YHV and WSSV in Thailand and establish in Australia effective diagnostic capabilities against the two diseases. It also aimed to develop molecular epidemiological tools for determining the relationship between different isolates of WSSV and YHV and for tracking movement of the viruses in the region. Finally researchers aimed to improve the capability of laboratories in Thailand and other Asian countries to undertake molecular virology and molecular epidemiology, and to boost the linkages in prawn aquaculture research between Thailand and Australia.

Project outcomes

The project developed a generic method for sample collection, preservation, transport, storage and nucleic acid extraction that was suitable for both WSSV and YHV viruses, even though the two virus types are fundamentally different in both structure and chemistry. The method was successfully tested in a national survey for WSSV and YHV conducted in Australia.

Methods developed for detection of WSSV and YHV using the polymerase chain reaction (PCR) process have been standardised, documented and distributed for workshop participants and participating laboratories. Standardised diagnostic testing methods for the two viruses have been submitted for inclusion in the OIE (Office International des Epizooties) Diagnostics Manual for Aquatic Animal Diseases.

The scientists were able to determine that YHV and GAV are closely related but distinct viruses, resulting in their separate listing by OIE. Their research also enabled more accurate taxonomic classification of the viruses. Other advances included a test for detecting YHV that allows grading of the severity of virus infection. A new strain of YHV that occurs widely in healthy prawns was identified, and this will have implications for future hatchery disease screening and management strategies.

Work to characterise the genome of WSSV was curtailed because laboratories elsewhere were making rapid progress with the research. The recent public release of complete genome sequence data has now provided tools that will allow molecular epidemiological studies of WSSV to proceed. However, the project developed improved PCR tests for WSSV detection and grading of severity of infection. These tests also helped to identify carriers of WSSV infection, which included insects as well as several crab species.

The project has had significant impact. In Thailand there has been a considerable recovery from the disease-related production slump that was apparent at the commencement of the project, and a valuable proportion of the credit for this can be attributed to the project. In Australia there was significant improvement in the knowledge base of industry and government and a lift in the national capacity to respond to exotic disease. Far better disease management strategies have emerged throughout the region, helped by regional consultations and workshops associated with the project, the preparation and distribution of standard diagnostic procedures and the commercialisation of diagnostic kits.

FIS/1997/073: Improved hatchery and grow-out technology for grouper aquaculture in the Asia-Pacific region

Overseas Collaborating Countries:	Indonesia, Philippines, Thailand
Commissioned Organisation	Queensland Department of Primary Industries, QDPI Northern Fisheries, Australia
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Collaborating Institutions	Research Institute for Coastal Fisheries, Indonesia
	Research Station for Coastal Fisheries, Indonesia
	Southeast Asian Fisheries Development Centre, Philippines
	Network of Aquaculture Centres in Asia Pacific, Thailand
	CSIRO Marine Research, Australia
	Bluewater Barramundi Ltd, Australia
	Australian Barramundi Farmers Association, Australia
Project Budget	$805,406
Project Duration	01/07/1999 to 31/12/2003
	(Project extended from 01/01/2003 to 31/12/2003)
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Groupers are reef fish of considerable economic importance. Their high value means that there is much interest in the development of aquaculture for them, particularly in the Asia-Pacific region and in Australia. The large and increasingly affluent market for live reef fish such as grouper, particularly in Hong Kong and southern China, has increased pressure on stock in the wild. In many areas the demand for live reef fish, and the large profits to be made by their supply, has encouraged over-fishing and the use of destructive and environmentally damaging practices to acquire the fish. This includes putting sodium cyanide in the sea to immobilise the fish so that they can be caught easily by divers. Many fish, and presumably other organisms, are killed in the process and the reefs are devastated.

Much of this can be avoided by growing desirable reef fish in aquaculture. The main problem restricting aquaculture for groupers is their very variable, and often rather poor, survival in the larval stage. Another difficulty is the supply of fish for feed—referred to as 'trash' fish. These low-value fish, which could be used for human consumption in low-income countries, are increasingly being put into aquaculture feeds for high-value fish. In some areas their supply is dwindling.

Recent international workshops have identified areas where research is necessary to develop commercially viable aquaculture for groupers. The overall objective of this project was to increase production of grouper reef fish in the Asia-Pacific region by developing improved hatchery and grow-out technology.

Project outcomes

Larval rearing

- Optimising environmental variables of temperature, salinity, aeration, and light levels provided valuable information contributing to greater larval survival.
- Larval nutrition research indicated the essential fatty acid requirements of one species of grouper (*Epinephelus coioides*). Further work will be aimed at developing larval diets to provide suitable levels of various fatty acids the larvae require.
- Research described the development of the digestive tract in larval groupers. This is fundamental to knowing the capacity of the larvae to digest both live and artificial feeds.
- Highly sensitive fluorescent techniques were developed to assess the levels of digestive enzymes in the gut of fish larvae. Grouper larvae were shown to have very low levels of digestive enzymes (e.g. protease) compared with some other species of fish larvae that

have been examined, such as barramundi. This may help explain why grouper larvae are more difficult to rear than barramundi.

- Assessment of techniques to maintain or decrease the size of super-small (SS) strain rotifers (*Brachionus rotundiformis*) for use in grouper hatcheries.
- Improved intensive and semi-intensive larval rearing techniques resulted in survival rates increasing from around 3 per cent at the beginning of the project to 30 per cent for greasy grouper / estuary cod (*E. coioides*), and from 5 per cent at the beginning of the project up to 50 per cent for humpback grouper/barramundi cod (*Cromileptes altivelis*).
- The viral disease viral nervous necrosis (VNN) continues to cause major mortalities in hatchery-reared grouper and remains a major limiting factor in successful seed production.
- Technology developed under the project has been adopted by farmers, including 'backyard hatcheries' in Bali. A socio-economic analysis of these small-scale hatcheries demonstrated that they are highly profitable, with payback periods generally <1 year and IRRs of 12–356 per cent.

Grow-out diet development

- Protein of Australian meat and bone meal and wheat gluten and local and imported fishmeal was found to be well digested (Apparent Digestibility (AD) >76 per cent). The protein digestibility of Australian blood meal was variable but generally low as also was the digestibility of rice bran. Intermediate in protein digestibility were local ingredients such as shrimp head meal, palm oil cake meal and soybean meal.
- Research with humpback grouper/barramundi cod (*C. altivelis*) showed that diets had to be high (> 55 per cent) in protein and moderate (12–15 per cent) in lipid to optimise growth rate and nutrient retention in the fish. Increasing the amount of lipid in the diet only increased fat deposition without any improvement in growth or food conversion efficiency. These findings need to be confirmed with other grouper species.
- Other research showed that many terrestrial protein meals have potential as partial replacements for fishmeal in grouper grow-out diets. Good quality meat and bone meal can replace more than two-thirds of the fishmeal without any adverse effect on grouper performance. Plant protein meals such as soybean and lupin have been shown capable of successfully replacing from one-third to half of the fishmeal.
- Researchers in Indonesia have categorised (cost, seasonal availability, composition, digestibility) a range of potential ingredients for use in locally-made grouper diets.
- Commercial feed producers in Indonesia and the Philippines are now trialling grouper diets based on the outcomes of the project's research.

FST/1996/005: Development of domestication strategies for commercially important species of *Meliaceae*

Overseas Collaborating Countries:	Laos, Malaysia, Thailand, Vietnam
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
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Collaborating Institutions	National Agriculture and Forestry Research Institute, Laos
	Forest Research Institute of Malaysia, Malaysia
	Royal Forest Department, Thailand
	Forest Science Institute of Vietnam, Vietnam
	CSIRO Entomology, Australia
	CSIRO Plant Industry, Australia
Project Budget	$572,857
Project Duration	01/01/1999 to 31/12/2003
	(Project extended from 01/01/2002 to 31/12/2003)
ACIAR Research Program Manager	Mrs Heather Crompton

Project background and objectives

Major areas of the world's tropical forests are being destroyed and strategies need to be developed to domesticate and improve important indigenous forest trees. This project focused on the indigenous tree, *Chukrasia* in Vietnam, Lao PDR, Malaysia and Thailand, and on the related Red Cedar (*Toona ciliata*) in Australia. It aimed to develop domestication strategies and to identify superior germplasm. Scientists reviewed information on *Chukrasia* and surveyed its distribution. They assembled germplasm in collaborating countries and identified superior provenances for specific sites. The project also developed propagation protocols and methods for studying the floral biology of *Chukrasia* and *Toona*.

Project outcomes

The project addressed two related problems that constrain development in the forestry sector of many tropical countries. These are the need to develop strategies for, and to initiate, the domestication of important indigenous forest trees, and the need to develop the scientific capacity of the national forestry research institutes to perform this work.

Research focused on a commercially important indigenous tree (*Chukrasia* spp.) that is being overexploited in the wild, but not grown commercially in plantations, and on a related species (*Toona ciliata*) in Australia. Both species are in the *Meliaceae* (mahogany) family and suffer from shoot borers (*Hypsipyla* spp.).

Reviewers found that the project made a good start towards the development of *Chukrasia* as a new forestry/agroforestry species to meet the need for more diversified production systems. The research took place in areas where it can have immediate impact through the dissemination and implementation of the findings.

Project scientists made a major contribution towards the collection of germplasm, seed procurement and the initiation of tree improvement in *Chukrasia*. The study of reproductive biology provided information of importance for a future breeding program. Other information will form the basis of a future domestication strategy.

A great deal of data emerged from the project and these are being analysed substantially beyond the project life. The reviewers identified the need for further analysis that attempts to explain the reasons for the provenance variations in performance.

Reviewers also highlighted the need for information about shoot borer (*Hypsipyla*) damage to *Chukrasia*, since this will be crucial in any decision about a domestication strategy for the

species. They recommended closer links with another ACIAR project (FST/1997/024: Insect resistance and silvicultural control of the shoot-borer, *Hypsipyla robusta*, feeding on species of Meliaceae in the Asia-Pacific region), with the aim of evaluating genetic variability in resistance/tolerance to shoot borer attacks and the selection of individual trees for clonal propagation.

The researchers found greatly superior performance of *Chukrasia* in farmers' fields in Vietnam, compared with forestry sites. This strongly suggests that the species has a good future as an agroforestry species. The usually greater agrodiversity and biodiversity of smallfarmers' fields in the tropics is also likely to be beneficial from the point of view of reducing shoot-borer attacks.

Much of the information gathered in the project has been published in ACIAR monograph 98, *Domestication of Chukrasia* (K Pinyopusarerk & A Kalinganire), 2003.

FST/1997/024: Insect resistance and silvicultural control of the shoot borer, *Hypsipyla robusta*, feeding on species of *Meliaceae* in Southeast Asia and Australia

Overseas Collaborating Countries:	Laos, Malaysia, Philippines, Thailand, Vietnam
Commissioned Organisation	CSIRO Entomology, Australia
Project Leader	Dr Rob Floyd
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Collaborating Institutions	National Agriculture and Forestry Research Institute, Laos
	Forest Research Institute of Malaysia, Malaysia
	Department of Environment and Natural Resources, Philippines
	Royal Forest Department, Thailand
	Forest Science Institute of Vietnam, Vietnam
	Queensland Forest Research Institute, Australia
Project Budget	$1,093,268
Project Duration	01/01/1999 to 31/12/2003
	(Project extended from 01/01/2003 to 31/12/2003)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Damage from the shoot borer *Hypsipyla robusta* has made it difficult to grow plantations of trees belonging to the family *Meliaceae*, which include Australian red cedar (*Toona ciliata*), *Chukrasia tabularis*, the mahoganies *Swietenia* spp. and *Khaya* spp., and West Indian cedar (*Cedrela odorata*). All these species produce extremely valuable timber if the young growing tips are not damaged by *Hypsipyla*, because the damage leads to extensive branching, poor form and slow growth. The aim of this project was to find genetic resistance to *Hypsipyla* in *T. ciliata* and *C. tabularis* and understand mechanisms of resistance. The scientists also tested the effectiveness of mixed species plantings and other silvicultural options in reducing *Hypsipyla* damage.

Project outcomes

Hypsipyla robusta is a highly damaging forest pest in terms of both level of attack per individual tree and percentage of trees attacked in each plantation. The project scientists evaluated a wide range of genotypes for genetic resistance to *Hypsipyla*, and investigated whether silvicultural manipulations could ameliorate the problem.

Four *Toona ciliata* and 11 *Cedrela tabularis* genetic resource trials were established and monitored. They found no outstanding seedlots of *Toona ciliata* in terms of resistance to *Hypsipyla* but there is some possibility that individual genotypes may prove to have some resistance. Other trials and experiments focused on issues including pruning, fertilising, insecticides, shade effects, and host selection.

Height: The dominant pattern in all trials was a positive relationship between tree height and *Hypsipyla* damage. If one was to select for fast-growing trees one would unwittingly select for trees that attract more insect damage. The focus for improvement must be on selecting trees that are relatively little damaged in spite of good growth, or that maintain good form in spite of *Hypsipyla* damage.

Species differences: Khaya senegalensis, *Cedrela odorata* and *C. tabularis* performed well relative to the average *T. ciliata*. In general these three species grew longer boles and received less *Hypsipyla* damage. *K. senegalensis* was the least frequently damaged species. The relative merit of each species depended on the site.

Pruning: Pruning trials on *C. tabularis* and *T. ciliata* found no advantage in form or growth of trees.

Shade: Growth of *T. ciliata* was examined under an overstorey and in a forest gap. These trees showed performance that exceeded any open-planted *T. ciliata*. Laboratory experiments support this result, indicating *Hypsipyla robusta* prefers to lay eggs on leaves grown at high light. These experiments suggest the most promising approach to *T. ciliata* silviculture is management of a light environment that optimises the balance between tree growth and insect damage.

Plant chemistry: Scientists found that leaf chemistry predicts variation in the *H. robusta* damage of *T. ciliata*. Gas chromatography of *T. ciliata* leaf extracts shows that trees with low damage have more of the compound bicyclo-elemene. They also found differences comparing leaves from high and low light, correlated with the shading effect on oviposition. Together these results indicate that variation in *H. robusta* attack is driven by plant chemistry. Damage reduction requires environments that make the trees constitutively less attractive to *H. robusta*.

Genetic improvement: In the fastest growing *C. tabularis* trial the best seedlot had mean bole lengths approaching 4 m after 36 months. Seedlot 20204 was a consistently good across many sites, ranking among the best with regards bole length, frequency of *Hypsipyla* damage and branching. In contrast, *Hypsipyla* damage was so intense in the *T. ciliata* genetic resource trials that no seedlots and very few individual trees looked 'forestry-ready'. Nevertheless there were significant effects of seedlot on important traits. For example, seedlot 109 was significantly better than most seedlots with regards bole length, frequency of *Hypsipyla* damage, and branching. The presence of seedlot effects on plant traits suggests selection or cloning has the potential to produce better trees.

Also, some seedlots were ranked in the top ten across several of the countries and these, plus a small number of well-performed individual trees could form the basis of further research and demonstration trials. Some seedlots of non-*Toona* species such as *Chukrasia* and *Khaya* in some countries have potential for promotion for future plantings because of their stronger growth, lower attack by Hypsipyla and their ability, particularly in the case of *Chukrasia*, to form a vigorous new terminal shoot with a high angle of recovery.

PHT/1993/877: Low cost disinfestation systems for fruit

Overseas Collaborating Countries:	Thailand, Vietnam
Commissioned Organisation	Queensland Department of Primary Industries, Horticulture Postharvest Group, Australia
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	Ministry of Agriculture and Rural Development, Vietnam
	Research Institute of Fruit and Vegetables, Vietnam
Project Budget	$871,137
Project Duration	01/01/1998 to 31/12/2003
	(Project extended from 01/07/2001 to 31/12/2003)
ACIAR Research Program Manager	Dr Greg Johnson

Project background and objectives

International trade of fruit and vegetables in the Asia Pacific region including Australia is severely constrained by quarantine barriers against fruit flies. Trade barriers also exist within Australia. The removal of barriers requires a postharvest disinfestation treatment. Heat and cold treatments that produce no residues, are now favoured over chemical applications. However, heat and cold treatments frequently affect fruit quality and disease development and control, and are technically complicated to apply. This project investigated alternative, low-cost heat systems with the aim of reducing the complexity of the technology. This is expected to lead to substantial reductions in cost and improve the feasibility for making the treatment available for use at the farm level.

Project outcomes

The project has been primarily focussed on the development of methods of heat treating fruit for quarantine disinfestation against fruit flies which could be achieved using low-cost treatment equipment developed by the Queensland Horticulture Institute. In Australia, the development and commercialisation of this equipment has progressed to the point where a commercial unit of five tonne capacity has been produced at a substantially lower cost than any other commercial equipment available.

The first objective was to establish appropriate facilities for disinfestation research in Vietnam (including fruit fly culture and postharvest physiology studies). Laboratories at Vietnam's Plant Protection Department (PPD) and the Research Institute for Fruit and Vegetables (RIFAV) were refurbished, colonies of two fruit fly species were established and the methodology for in vitro thermotolerance studies standardised. Vietnamese staff were trained in fruit fly culturing techniques, management of the fly colony, and development of disinfestation treatments, in collaboration with the Department of Agriculture quarantine research group in Thailand. A low cost artificial medium was developed as a fruit fly diet. RIFAV staff were provided with intensive training in use of the equipment provided and in postharvest experimental methods, covering such areas as experimental designs, quality and sensory evaluation methods and statistical analysis. The research leader received additional specialist training and management training in Australia as a recipient of an ACIAR-funded John Dillon Fellowship.

The second objective was development of heat treatment conditions. In Thailand the mangosteen, pomelo and longan have been investigated. The Department of Agriculture in Thailand has now satisfied all technical requirements to obtain entry of mangosteen to Japan, and commercial shipments were able to commence. The project has demonstrated that slower heating rates reduced the incidence of fruit injuries, while there was no difference in injury incidence between air and water cooling. Air cooling is preferred however, because its slower cooling rate will not impact on treatment efficacy. In 2002, the disinfestation systems were further developed to minimise fruit injury and disease development in litchi, oranges and mangoes. A commercial collaborator is assisting with installation of a demonstration pilot-scale heat treatment unit.

RIFAV undertook storage studies of lychee, demonstrating that shelf life can be prolonged up to 35 days with an acceptable loss of quality. Preliminary experiments on the effects of heat on dragon fruit quality have shown that hot water dipping (52°C for 10 minutes) results in no loss of quality. This work is continuing.

Achieving treatment efficacy at the levels for many importing countries can be difficult without causing product injury. Some of the Australian research looked at technical options for reducing damage risk while maintaining treatment efficacy. It was hypothesised that slow air heating using low temperatures and relative humidity's in the early stages of treatment, can reduce the incidence of fruit injuries. This approach was assessed on mangosteen, tomato, mango and papaya. Pre-treatment conditioning at 38°C for 12-18 hours was found to be very effective in reducing injury development induced at higher temperatures but the treatment efficacy also fell under these conditions. An alternative approach to increasing treatment efficacy consisting of a pre-treatment using atmosphere modifications was investigated.

High levels of insect mortality occur when a low oxygen pre-treatment stage was incorporated in the total treatment process using milder temperatures. Elevated carbon dioxide appeared to have little effect. In the early stages of the work, pre-treatments were carried out in converted incubators and product was manually transferred to the heat treatment chamber. This led to inconsistent and difficult to interpret results. Improvement of treatment systems was completed within a complementary project (funded by Australian agencies) by fabricating a dedicated low oxygen treatment chamber. Effective treatment conditions, which do not injure the fruit, have been developed for disinfestation of 'Kensington' mango for *Bactrocera jarvisii.* Similar work for papaya is well advanced.

A third objective involved development and evaluation of low-cost treatment systems. An experimental version of the new treatment system developed in Australia was supplied to the PPD in Hanoi. This unit was designed to treat up to ten crates each containing up to 10 kg of product. The unit can be operated fully automatically if required. The was used to investigate heat tolerance of immature stages of two fruit fly species, *Bactrocera dorsalis* and *Bactrosera cucurbitae*, leading to determination of the most tolerant stage of *B. dorsalis* in dragon fruit. In Vietnam the ACIAR project is linked with an AusAID-funded CARD project, which has enabled additional capacity-building through the involvement of engineers at the University of Agriculture and Forestry in Ho Chi Minh City in the construction of a second prototype treatment unit at PPD in Ho Chi Minh City, using locally available materials.

Towards the end of the project, when a suitable site became available at RIFAV, a small pilot commercial unit was installed. While the capacity of the unit was only slightly higher than the experimental units built previously, the design was such that it provided a concept for scaling up to small commercial scale. In Australia the project also provided some technical support to commercial scale-up of the treatment technology.

The use of disinfestation heat treatment is a preferred disinfestation technology in the Asian and Pacific region. Many countries maintain an active interest in the system. They may be currently developing and using the process for export, or needing to evaluate data generated in the systems in submissions for import approval. Other countries are working towards being able to utilise the process. For these reasons, harmonisation of treatment development and broad agreement on experimental data development methods and interpretation is of significant importance to trade in the region. The project contributed to draft 'Guidelines for the development of quarantine disinfestation heat treatments for fresh horticultural produce for fruit flies' developed through an APEC workshop and a follow-up meeting.

PHT/1995/134: Management of *Phytophthora* diseases of durian

Overseas Collaborating Countries:	Thailand, Vietnam
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	Southern Fruit Research Institute, Vietnam
	Department of Business, Industry and Resource Development, Northern Territory, Australia
	Queensland Department of Primary Industries, Australia
Project Budget	$649,280
Project Duration	01/07/1998 to 31/12/2003
	(Project extended from 01/01/2002 to 31/12/2003)
ACIAR Research Program Manager	Dr Greg Johnson

Project background and objectives

The popular tropical fruit durian is prone to fungal diseases, notably fruit rot, root rot, patch canker and dieback, largely due to the *Phytophthora* fungus. Market losses from these conditions are in the order of 15–30 per cent, and the impact is felt elsewhere in the loss of trees and in postharvest rots that can destroy whole consignments in storage and transit. This project developed an integrated disease management strategy, based on information gathered on the host range, geographical distribution and virulence of *Phytophthora* strains isolated from different durian-growing areas. The scientists also tested how injecting phosphonates directly into the tree can control the fungus. Phosphonates have a low toxicity for mammals and have been found highly effective in controlling *Phytophthora* diseases in cocoa and avocado.

Project outcomes

In line with the primary aim of the project, the key output was a set of recommendations for the integrated control of *Phytophthora* diseases in durian in each location for disease control, from the nursery through to postharvest handling:

Disease control in nurseries: Pathogen-free potting media is fundamental to producing healthy plants, yet the cost of soil pasteurisation equipment is currently beyond the finances of most private nurseries in Vietnam. The project team recommended a search for alternatives to coconut fibre and rice husk, because the research showed that potting media used in Vietnam harbour *Phytophthora*. Researchers developed bioassays to screen durian germplasm for disease resistance, and put forward local recommendations for propagation of disease-tolerant varieties.

Disease control in orchards: Integrated disease management (IDM) in orchards is achieved through planting disease-tolerant material (wherever possible), by implementing appropriate orchard management practices, cultural and biological controls and through the judicious use of appropriate chemicals. The project demonstrated the efficacy of composted animal manures in improving tree health and reducing disease incidence, and recommended time and rate of application. Other outcomes included identifying suitable cover crops for durian in Australia's Northern Territory (NT), and identifying local sources of suitable mulch and care in its removal in the wet season. The scientists demonstrated the role of fallen fruit, at all stages of development, as sources of inoculum that harbour *Phytophthora* and other pathogens. They developed recommendations for the rate and timing of phosphonate trunk injections, which have proven spectacularly successful in ameliorating patch canker in Vietnam.

Postharvest disease control: Controlling *P. palmivora* in the orchard improves the quality of the harvested fruit. Specific fruit treatments were formulated to further reduce the incidence of fruit rot. Manual harvesting, as conducted in Thailand, was recommended for all regions.

However, as harvesting indices were not available for the highly variable Vietnamese cultivars, the scientists recommended that fruit be tied to branches to allow natural abscission without the associated disease and injury problems of allowing the fruit to drop to the ground.

Technology transfer: A top priority of this project was the dissemination of recommendations to the durian industry. This process has been greatly assisted by the fact that the collaborating institutions are either extension agencies or have a strong extension culture. Research findings and recommendations have been communicated through training courses, on-farm demonstrations, the use of electronic and written (newspapers, magazines, pamphlets) media, project website and growers groups.

Capacity building: This project has made a significant contribution to horticultural research capacity of the partner countries, especially Vietnam. The skills and research capacity of collaborating institutions have been significantly enhanced through this project, which has not only had direct positive impact on the results achieved, but will provide a lasting legacy for institutions and scientists.

PHT/1996/193: Survey of the presence and importance of *Phytophthora* in Southeast Asia

Overseas Collaborating Countries:	Indonesia, Malaysia, Philippines, Thailand, Vietnam
Commissioned Organisation	Cooperative Research Centre for Tropical Plant Protection, Australia
Project Leader	Dr Andre Drenth Phone: 07 3896 9345 Email: Andre.Drenth@dpi.qld.gov.au
Collaborating Institutions	Research Institute for Spice and Medicinal Crops, Indonesia Malaysian Agricultural Research and Development Institute, Malaysia Bureau of Plant Industry, Philippines Kasetsart University, Thailand Prince of Songkla University, Thailand Southern Fruit Research Institute, Vietnam
Project Budget	$149,943
Project Duration	01/07/2000 to 30/06/2003 (Project extended from 01/07/2002 to 30/06/2003)
ACIAR Research Program Manager	Dr Greg Johnson

Project background and objectives

Phytophthora spp. are amongst the most important plant pathogens worldwide, causing large losses in agriculture. Many important crops in Southeast Asia and Australia are susceptible, including citrus, rubber and cocoa. At the regional and individual level, farmers have little information available about *Phytophthora.* The project aimed to consolidate information already known about the pathogen. The scientists conducted a disease survey in Southeast Asia about practical *Phytophthora* problems in agriculture and forestry. They also identified local expertise and assessed the facilities available in the collaborating countries. This information has provided a basis for workshops on *Phytophthora* and for designing subsequent research projects.

Project outcomes

One of the main outcomes from the *Phytophthora* survey is a detailed overview of different *Phytophthora* diseases that have been identified in the collaborating countries in Southeast Asia. In a range of important major crops such as cocoa, pepper, durian, rubber, coconut, citrus, potato, tomato, and papaya significant losses occur on an annual basis with disease epidemics under favourable weather conditions. By far the most common and important *Phytophthora* species is *P. palmivora* that occurs on a range of different host plants. *P. nicotianae* is also important on a range of crops including citrus, while *P. capsici* is causing considerable losses in the production of pepper. *P. infestans* is important in the highlands, where it causes significant losses to potato and tomato production.

Another major outcome of the survey is a significant increase in the ability of many researchers in the region to recognise disease symptoms caused by *Phytophthora* at an early stage. To aid the transfer of knowledge in this area a small handbook, 'Practical guide to detection and identification of *Phytophthora*', was written and widely distributed.

The project involved hands-on training in the field to detect, identify and manage plant diseases caused by *Phytophthora* in various locations in all five countries involved. This training in early disease detection allows targeted control of *Phytophthora* diseases in the field. In addition to the Practical Guide all participants were also provided with a comprehensive reference book on the genera *Phytophthora*. The impact of this increased capability to recognise and deal with *Phytophthora* diseases should form the foundation for improved detection, identification and control of *Phytophthora* diseases in the years ahead.

An important output of this project is input in other ACIAR projects (PHT/1995/134 Management of *Phytophthora* diseases of durian; PHT/2000/102 Selection for improved quality and resistance to *Phytophthora* pod rot, cocoa pod borer and vascular streak dieback in Indonesia; and CS2/1994/965 Diagnosis and control of plant disease in northern Vietnam.) At the end of this project a workshop was held in collaboration with the durian project (PHT/1995/134) in Chiang Mai in October 2002. During this workshop information regarding the occurrence, aetiology, and management of *Phytophthora* was reviewed and recommendations for integrated management of *Phytophthora* diseases discussed. In addition it brought together scientists from the collaborating countries to share information and form professional linkages throughout the region.

Detailed information concerning the occurrence, distribution, impact and management of different *Phytophthora* diseases in Southeast Asia is being collated in a monograph on *Phytophthora* in Southeast Asia which is being published by ACIAR as Monograph 114.

AS1/1997/133: Sustainable endoparasite control for small ruminants in Southeast Asia

Overseas Collaborating Countries:	Indonesia, Malaysia, Philippines, Thailand
Commissioned Organisation	International Livestock Research Institute, Philippines
Project Leader	Dr Greg Hood
	Phone: + 63 2 845 0563 ext 2675
	Email: ghood@cgiar.org
Collaborating Institutions	Research Institute for Veterinary Science, Indonesia
	Universiti Pertanian Malaysia, Malaysia
	Veterinary Research Institute, Malaysia
	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, Philippines
	CSIRO Livestock Industries, Australia
Project Budget	$599,370
Project Duration	01/07/1998 to 30/06/2004
	(Project extended from 01/07/2001 to 30/06/2004)
ACIAR Research Program Manager	Dr John Copland

Project background and objectives

This project was a significant component of the International Livestock Research Institute's (ILRI) extension to Southeast Asia. The broad aim was to bring together relevant experiences and expertise from ILRI and the Australian and Southeast Asian collaborating institutions to study endoparasites (internal parasites) in sheep and goats. The specific objectives were to develop, test and implement options for sustainable endoparasite control strategies, to identify endoparasite-resistant goat breeds/genotypes in Southeast Asia and assess the contribution of these resistant genotypes to sustainable endoparasite control. The team also assessed the level and extent of anthelmintic resistance and evaluated the Larval Development Assay (LDA) under tropical conditions in Southeast Asia.

Project outcomes

Development and testing of sustainable integrated strategies for the control of endoparasites

A study was conducted at Babajurang, West Java on the long-term benefits of nutritional supplementation during the wet season with non-medicated urea-molasses blocks. The urea-molasses blocks were effective in maintaining weight gain during the targeted period of nutritional challenge during the rainy season. Anthelmintic (Valbazen) was administered separately at two-weekly intervals to half the supplemented animals, and to half the non-supplemented controls, resulting in a significant and sustained benefit of about 2.2 kg per head. A key positive feature is that this experiment was carried out on farms, with farmers, which gave villagers regular exposure to improved knowledge and skills and an elevation in social esteem.

The development of Indonesian research capacity was highly significant, involving collaboration between several institutes. The outcomes of this component of the project were incorporated in the planning for International Fund for Agricultural Development (IFAD) activities at Babajurang and other IFAD sites. A survey of the knowledge, attitudes and expectations of 25 farmers provided a valuable starting point for community awareness and involvement in projects. A major impediment to the adoption of this technology is its initial investment cost in a depressed economic environment, which is a major factor in the design of the delivery of the ACIAR project benefits through the IFAD project.

Four studies were also conducted in the Philippines to examine the effects of strategic supplementation of goats in the dry and rainy seasons with urea-molasses blocks containing an anthelmintic.

Assessment of the extent of anthelmintic resistance in sheep and goat populations in Southeast Asia using the Larval Development Assay (LDA)

The LDA has been developed and applied in Philippines and Indonesia with early support from CSIRO and an extensive technical training program. Widespread drench resistance has been identified in the Philippines, highlighting the urgency and importance of reducing the impact of resistance and developing alternative control strategies. This confirms that SPC research initiatives in the current project are immediately relevant in the national interest. This research activity provides a series of examples of good scientific planning, rigour, attention to task, careful management and sharing of resources and responsible administration. Following the inclusion of data for Mindanao and Indonesia the paper will benchmark similar surveys planned in other countries of Southeast Asia by IFAD. Very little larval development assay resistance testing has been completed in Indonesia, and more needs to be done.

CS2/1998/078: Sustainable integrated management of whiteflies as pests and vectors of plant viruses in Asia

Overseas Collaborating Countries:	Bangladesh, Indonesia, Malaysia, Nepal, Philippines, Sri Lanka, Thailand, Vietnam
Commissioned Organisation:	International Centre for Tropical Agriculture, Colombia
Project Leader	Dr Francisco Morales
	Phone: + 57 2 4450 000 x3379
	Email: f.morales@cgiar.org
Collaborating Institutions:	Bangladesh Agricultural Research Institute, Bangladesh
	Bogor Agricultural University, Indonesia
	Malaysian Agricultural Research and Development Institute, Malaysia
	Nepal Agricultural Research Council, Nepal
	University of the Philippines at Los Banos, Philippines
	Regional Agricultural Research and Development Centre, Sri Lanka
	Asian Vegetable Research and Development Centre, Taiwan
	Department of Agriculture, Thailand
	Cantho University, Vietnam
	Institute of Agricultural Sciences of South Vietnam, Vietnam Research Institute of Fruit and Vegetables, Vietnam
	CSIRO Entomology, Australia
	CSIRO Plant Industry, Australia
Project Budget:	$562,000
Project Duration:	01/01/1999 to 31/12/2003
	(Project extended from 01/01/2002 to 31/12/2003)
ACIAR Research Program Manager:	Dr Wendy Morgan

Project background and objectives

Whitefly (*Bemisia tabaci*) is one of the most intractable and devastating pests of vegetable and cotton industries throughout the world. Not only is its effects felt from the damage caused by feeding, but in many cases it is also responsible for the transmission of plant viruses that, when they occur together, often result in total crops losses. This project was part of the Tropical Whitefly IPM Project, coordinated by CIAT. It involved collaboration between CSIRO Entomology and CSIRO Plant Industry in Australia, AVRDC in Taiwan and collaborators in Sri Lanka, Bangladesh, Malaysia, Indonesia, Philippines, Thailand, Nepal and Vietnam. It aimed to improve understanding of whitefly in the Asian region, determining its extent and studying the dynamics of the virus diseases it carries. A number of surveys and collection missions in the collaborating countries were undertaken to identify different whitefly biotypes, host plants, natural enemies and associated plant viruses.

In Vietnam, the overall goal of the project was to identify components for inclusion in a sustainable integrated pest management (IPM) strategy for control of whitefly-transmitted geminiviruses and whiteflies on tomato. Two Vietnamese institutions agreed to join the project in June 2002 so that experiments could be conducted in northern and southern Vietnam under diverse environments.

Project outcomes

Two genetically distinct tomato-infecting geminiviruses from north and southern Vietnam were isolated, cloned, and sequenced. The virus from north Vietnam is most similar to a geminivirus from Taiwan (88% homology) while the virus from southern Vietnam is a strain of a geminivirus from Thailand. The chances are high that AVRDC-resistant lines will hold up against the virus from northern Vietnam or similar viruses. Reaction of AVRDC resistance to the virus from the south is unknown and needs to be determined. The wide range of genetic diversity among the geminiviruses from Vietnam and other parts of Southeast Asia emphasises the importance of developing resistant lines carrying multiple resistance genes in order to have effective and durable resistance in the region.

After two years of on-station and on-farm testing in north Vietnam, two fresh market tomato hybrids, FMTT847 and TLCV15, were identified as highly promising for farmer adoption. Under moderate or high geminivirus pressure in farmers' fields, these two hybrids yielded 30-400% more than local geminivirus-susceptible cultivars. Parental lines of the hybrids have been provided to the Research Institute of Fruit and Vegetables, Vietnam (RIFAV) to enable seed production of the hybrid for farmers. AVRDC will make these two hybrids available to researchers in other countries for evaluation and possible release. However, both hybrids were susceptible to geminivirus when tested in an on-station trial at Cantho University in southern Vietnam.

The efficacy of petroleum spray oil (PSO) versus conventional pesticide and control (water) treatments in reducing/repelling whitefly populations and reducing geminivirus infection was evaluated in three on-station experiments at RIFAV in north Vietnam. Adult whiteflies but not nymphs were present on tomato plants, suggesting that local whitefly populations cannot complete their lifecycle on tomato. The *Bemisia tabaci* genetic group in north Vietnam may be Nauru instead of Asia 1 as previously thought. Weekly applications of PSO at rates of 1% or 2% reduced geminivirus incidence to 8-18% compared to 25% for the water control. For both non-resistant and resistant varieties, PSO application rates of 1% or 2% also increased marketable fruit yields by 50-92% compared to the water control. PSO technology combined with resistant varieties showed excellent potential as a component in an overall geminivirus IPM strategy and a safe substitute for insecticides. Furthermore, the large yield increases provide strong evidence that the PSO applications provide additional benefits to tomato crops beyond geminivirus control.

Projects under development

at 30 June 2004

Bilateral

AS1/2002/064 The development of cattle and buffalo breeding strategies and activities based on Breedplan in Thailand

AS1/2003/050 Epidemiology and control of important livestock diseases in Cambodia

AS1/2004/016 A systems approach to rodent management in upland environments in Lao PDR

AS2/2003/008 Enhancing beef production in Cambodia through better nutrition

AS2/2004/046 Forage-legume supplementation of village pigs

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

FIS/2002/112 Application of PCR for improved shrimp health management in India, Thailand and Indonesia

FIS/2003/072 Development of large-scale stock assessment techniques for freshwater fisheries in Cambodia

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

FST/2004/007 Domestication of Australian trees for reforestation and agroforestry systems in developing countries

FST/2004/015 Development of an Asia-Pacific regional strategy for the *Eucalyptus* Rust

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

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. Titles marked with an asterisk may also be downloaded from ACIAR's website, www.aciar.gov.au

Monographs

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*

Proceedings

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*
116 Water in Agriculture*

Technical reports

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
56 Feeds and Feeding for Inland Aquaculture in Mekong Region Countries

ACIAR 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 Aquaculture in Australia and Southeast Asia*