

Country Profile

Philippines

November 2005

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

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Preface

The ACIAR Country Profiles are designed to give a snapshot of the collaborative research being carried out between Australia and our key partner countries. This publication contains short summaries of bilateral and multilateral projects with the Republic of the Philippines that were active at 30 June 2005. At that time there were 22 active bilateral projects and 3 active multilateral projects, the latter being led by international agricultural research centres. There were another 8 bilateral projects under development, many of which are expected to start in 2005–06 financial year.

This publication also sets out the key outputs and outcomes from the 7 bilateral projects that have been completed since 30 June 2005.

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

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

We hope you find the publication useful as a record of the ongoing progress and achievements of ACIAR's collaborative research and development program with the Philippines. For information on ACIAR's overall program, we invite you to visit our website at www.aciar.gov.au.



Peter Core
Director

November 2005



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Philippines Report 2004–05

(extract from ACIAR Annual Report 2004–05)

Active projects in 2004–05	31
AOP budgeted expenditure in 2004–05	\$2,410,000
Actual bilateral country expenditure in 2004–05	\$2,295,395
Bilateral country expenditure in 2003–04	\$1,852,285
Bilateral country expenditure in 2002–03	\$2,948,986

Key performance indicators	Performance 2004–05
<ul style="list-style-type: none"> Evidence of strengthening of the interface between research and extension teams in at least four projects 	Two new postharvest technology mango projects both specifically include provincial agriculturists, who also participated in project planning meetings and in project management training.
<ul style="list-style-type: none"> New natural resource management projects underpinned by design processes that involve end-users of the research and address their needs 	Two natural resource management projects commenced that include partnerships with end-users in Landcare and smallholder tree farming projects with a further two projects under design.
<ul style="list-style-type: none"> Commencement of two ACIAR–AusAID jointly funded initiatives in response to undertakings made by Prime Minister Howard in July 2003 	Three projects—integrated pest management and supply chain improvement for mangoes, sustaining and growing landcare systems, and postharvest diseases of subtropical and tropical fruit commenced.
<ul style="list-style-type: none"> Improved tree nursery production practices implemented in private and community nurseries in Leyte 	A demonstration forestry seedling nursery developed, providing useful training and extension facility for community-based forestry programs in Leyte; two demonstration tree farms established for field trials.
<ul style="list-style-type: none"> Prospects for using biofertilisation to reduce pathogen damage to vegetables assessed 	Volatile compounds released from <i>Brassica</i> tissues following processing proven very effective in suppression of two important pests and diseases of solanaceous vegetables.
<ul style="list-style-type: none"> Evaluation of the ripening characteristics of glasshouse-grown genetically modified papaya fruit 	Evaluation of glasshouse-grown genetically modified papaya fruit undertaken and report submitted to ACIAR.
<ul style="list-style-type: none"> Increased awareness and cooperation on illegal, unreported and unregulated fishing issues at a national policy level 	Strong local leadership and good cooperation between relevant key agencies has contributed to excellent progress, with IUU audit of Philippines fisheries well advanced.
<ul style="list-style-type: none"> Evidence of farmer uptake of grouper and mudcrab hatchery technologies 	Limited uptake of mudcrab and marine finfish hatchery technologies to date, in part due to recent institutional restructuring at SEAFDEC.

Position

The Philippines and ACIAR have been partners in project activities since 1983. The current program emphasises market access and international competitiveness in the emerging global trade

environment. Improving export-quality commodities grown from aquaculture, plant and livestock industries and reducing contaminants are focal points. Project scientists are also working within agricultural systems, particularly those practiced by smallholders, to enhance their profitability and sustainability.

Geographically the program has shifted, focusing on the poorer areas of Mindanao and the Visayas. Such projects link the expertise in Manila and Los Baños to these outlying areas, and aim to increase the limited adoption of past project results. Increasing the involvement of end-users of the research is included in project design. ACIAR's program is also aligned with Australian Government initiatives to encourage closer technical cooperation in agriculture, focusing on postharvest improvements to reduce losses.

Achievements

Improving market access by improving supply chains is being addressed in two projects. The first is examining the mango industry from two aspects: the efficacy of integrated pest management approaches (the leading cause of fruit losses), and improvements in the supply chain. An analysis of this chain is under way and **areas for practical improvements of benefit to smallholders** are being identified. The efficiency of the agribusiness supply chain for smallholder vegetable producers on Mindanao has been scoped revealing the need for cooperatives to work together to change farming practices to produce improved quality vegetables. Those adopting the new approaches have reported increased returns, and there is an improved awareness of the role of market-driven agriculture to aid development in Mindanao.

A small suite of projects is addressing barriers to delivering high-quality commodities to markets, by developing improved germplasm. The first project is examining **cryo-preservation of seeds of several tropical fruit species**—including mango, papaya, citrus, persimmon and litchi—to overcome storage losses. The ability to 'revive' preserved lines using micropropagation and plantlet regeneration has been proven for several of the fruits. A second project is addressing control of papaya ringspot virus (PRS-V) by identifying resistant papaya varieties. Promising genotypes are being tested in glasshouse and field trials. Five molecular markers for genes linked to resistance have been found and two genetically sequenced.

Ripening of some tropical fruit is not uniform, resulting in losses due to harvest timing and postharvest. Two **genes involved in the ripening processes for papaya** have been identified in past research and have now been isolated and cloned. These genes have been introduced into papaya varieties with low expression, or activation of ripening, delaying this process in fruit still on trees. Several lines with the two genes incorporated have been developed and are being screened for ripening characteristics. This work may also apply for mangoes. Another project on mango is **seeking to reduce postharvest disease losses**. Mango and some other fruit trees have natural defences against such diseases during growth, but these do not always transfer to fruit after harvesting. Identifying these natural defences is helping the project team assess pre- and postharvest treatments. Several preharvest treatments have been developed and now tested by farmer groups. **Sprays to activate natural defences** after fruit harvesting are also being trialled, with initial results proving positive for banana.

A similar approach is being used to target the enzyme responsible for the development of **blackheart in pineapples**. Blackheart, difficult to detect prior to cutting a pineapple, renders fruit inedible. A reliable transformation technique to introduce resistant genes has now been refined and patented. This reliability has helped in the production of more than 5000 plants for field evaluation. The role of cold temperatures and fruit wounds in inducing blackheart have also been confirmed and are being considered for pre- and postharvest management strategies.

Assisting **smallholder livestock producers** maximise available returns is helping industry efficiency. Poultry producers farming chickens and ducks require improved management approaches if they are to remain competitive in an environment of growing domestic demand and increased trade liberalisation. A picture of supply chains in both sectors has emerged and researchers have identified where Government policy can assist in introducing improvements. Researchers are introducing the Australian-developed BREEDPLAN software to aid in the genetic improvement of ruminant species

(buffalo, cattle and goat). The software helps identify lines for incorporation into breeding programs, based on desired traits. A range of information specific to local conditions has been collected and introduced into software for Philippine requirements and is now in use.

Soil pathogens, such as bacterial wilt and root knot, have been controlled through fumigation with methyl bromide. This can lead to environmental damage and residual amounts of the fumigant on **produce in horticulture and vegetable production**. Sustainable management of these pathogens in smallholder vegetable systems is being tested using biofumigation (relying on the volatile compounds from Brassica plants) as a substitute for methyl bromide. Relevant agencies and institutions are learning about the improved management options through the project extension.

Three related projects are developing improved management options for pesticide and insecticide residues. Agricultural practices that contribute to residue mobilisation have been determined, including rates of soil absorption. A pesticide impact rating index has been adapted to these parameters and is now in use. Pesticide residues are also a problem on horticultural produce. Enzyme bio-remediation that degrades the toxic residues is being utilised. Trials of application protocols for the enzyme on eggplants and tomatoes found that up to **60 per cent of such residues can be removed within a one hour application**.

The final project in this suite involves integrated weed management to reduce herbicide use. The reliance of rice farming systems on herbicides to control weeds has encouraged the development of resistance in some weed species, leading to increased spraying and higher levels of residues in soils and water. An integrated weed management package has significantly lowered herbicide applications in initial field trials.

A project following on from the successful facilitation of Landcare group development has recently begun with the aim of assessing the factors behind adoption. It is also examining how to use these factors in **the expansion of Landcare beyond Mindanao** where initial activities were located. A related project, now concluded, examined community involvement in reforestation schemes to combat substantial land clearing on the island of Leyte. Researchers identified significant factors restricting forestry development.

Problems with **community nursery propagation practices** were identified and improved practices developed. A recently commissioned project is furthering these findings. Better management practices for **natural stands of bamboo** are being developed. These are introducing changes to harvesting, as a start to changing attitudes from short-term gain to longer-term income generation.

Water resources are being managed more sustainably on Bohol Island after assessing the extent of runoff and erosion. Using geographic information systems to gather data has allowed an evaluation of the extent to which erosion is caused by the six main cropping activities. Information on the socio-economic and policy issues that contribute to erosion-causing practices has also been collected, and researchers have demonstrated the need to integrate appropriate technologies into local planning and farming practices.

Assessment of wild stocks of another important resource—the giant freshwater prawn—has been completed in the Philippines and Indonesia. This revealed an extensive natural range throughout much of the Asia-Pacific region and significant natural diversity. Two **major population sets exist**, divided by a biogeographical line, with many diverse genotypes. Most farmed prawns originate from the same genetic group, so this information offers the possibility of introducing more diversity into stocks for culturing.

Two projects are building research capacity in key Philippine institutions. Extension services have become degraded and decentralised in the Philippines over the last three decades. How this process has affected farmers is being assessed through a dual approach to **determine the strengths and weaknesses of current public and private extension services** and how these have impacted on farmer decision-making. The aim is to find solutions by developing a framework that matches extension approaches to farmer needs. Another project is examining how seasonal climate forecasting could aid agricultural planners and participants, by developing an understanding of the factors constraining its introduction and applicability. As a start researchers wish to identify these factors, to help determine if the forecasting techniques suit the Philippines.

Philippines Plan 2005–06

(extract from ACIAR Annual Operational Plan 2005–06)

GNI per capita ¹	AUD 1, 665	Bilateral actual 2003–04	\$1.9m
Population ²	75.7 million	Bilateral forecast 2004–05*	\$2.4m
Population 2025/2050 ³	108.6 / 127.0 million	Bilateral budget 2005–06*	\$2.6m
Active bilateral projects	21	Multilateral budget 2005–06	\$0.4m
Active multilateral projects	3		

*Includes AusAID-funded projects: \$0.33m (forecast 2004–05), \$0.4m (budget 2005–06).

Medium-term strategy

The main aim of ACIAR cooperation is to assist the Philippines to increase the productivity, marketability, international competitiveness and market access for Philippine agricultural products, taking into account the impacts of trade liberalisation. Underlying competitiveness is the need to improve agricultural productivity to raise rural incomes through more effective extension of R&D and by responding to market opportunities with higher quality commodities produced at a competitive cost. Specific opportunities may come through research for development and marketing of aquaculture, crops, forestry and livestock products, applications of biotechnology for contaminant reduction and quality improvement, and farmer-driven improvements in agricultural systems.

Sustainability of agricultural production is a key concern, so research will be targeted to help ensure that improved productivity does not come at the expense of natural resources degradation, especially of uplands and fragile watersheds and coastal zones. Conservation and efficient use of water will assume increased importance. Our Philippines program has an increasing emphasis on involvement of Local Government Units, non-government organisations and farmer community groups in projects in order to increase prospects for sustainable adoption of the results of research, and on projects that implement the results of earlier ACIAR-supported research in the Philippines.

Key performance indicators (2005–06)

- Significant involvement of farmer groups and local government in participatory research and extension in ACIAR projects
- Systematic analysis of opportunities to extend the results of past ACIAR-funded research completed
- Policy papers delivered to key ministry planning groups on options for enhancing delivery of extension services in the Philippines
- Routine use of ruminant performance improvement systems by the dairy industry
- Community adoption of better watershed management practices in Bohol
- Initial assessment of the sustainable use of shallow groundwater for intensification of cropping in northern Luzon

¹ Source: Commonwealth of Australia, *Australia's Overseas Aid Program 2005–06*, Statement by Minister Alexander Downer, May 2005.

² Source: United Nations Population Division, 2004, *World Population to 2300*.

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

- Initial on-farm trials established for improved mango integrated pest and disease management approaches
- Description of the significance of migration and/or off-farm employment on roles of women and appropriate technologies in Philippine mixed farming systems
- 40% of new projects designed to have significant farmer or policy-maker impacts within 5 years of completion

Position

ACIAR's program in the Philippines has been active since 1983. Initially the program had several projects dedicated to research on soil management issues — nutrient management, erosion control, rice cropping systems, biological nitrogen fixation and tree establishment on degraded land. Research on postharvest storage of grain was also important. Culture success with giant clams, valued as food and for income through the shell trade, has enabled the largest and fastest growing species (*Tridacna gigas*) to be re-established in several areas where the species had become locally extinct. During the 1990s research cooperation shifted towards livestock management and biotechnology. A shift in project location, to emphasise the poorer areas of Mindanao, the Visayas and Luzon, but maintaining strong links to research and development expertise in Manila and Los Banos, will continue.

Improving uptake of research in the Philippines is a major challenge and priority, and, in collaboration with Philippines partners, ACIAR has increased its emphasis on better understanding extension processes and involving farmer and community groups in projects. In recent times there has been encouraging success with the adaptation of the Landcare approach in Mindanao, management of catchments in the Visayas island of Bohol, and in the uptake of methods for successful tree establishment on degraded lands. New research projects should be underpinned by design processes that involve the end-users of the research and address their needs. Project design should also accommodate the additional challenges that have arisen from the devolution of the management and governance of extension responsibilities to local government units, and the comparatively weak research–extension linkages that often currently exist.

With the main aim of ACIAR cooperation being to assist the Philippines to increase the marketability, international competitiveness and market access for Philippine agricultural products, ACIAR and AusAID have initiated some jointly funded activities in the areas of postharvest technology, disinfestation and pest management in fruits such as mango. ACIAR and AusAID are also cooperating in scaling out of the Landcare approach to farmer-driven natural resource management, and during 2005–06 will explore opportunities to link ACIAR-generated technologies with non-government and community-based organisations involved in the AusAID-funded Philippines–Australia Community Assistance Program.

After an active period of project development and initiation in 2004–05, fewer new projects will commence in 2005–06. However, an ACIAR–Philippines country consultation is due in early 2006 and in addition to establishing new priorities we will actively explore opportunities for enhancing farmer uptake of the results of current and past ACIAR-funded projects.

One major IARC, the International Rice Research Institute (IRRI), is headquartered in Los Banos, Philippines. ACIAR provides core funding to IRRI and also supports additional initiatives aimed at maintaining rice productivity.

Indicative priorities

ACIAR has a program of consultations with key partner countries on a four-year rolling basis to establish priorities for research collaboration. The most recent such consultation with the Philippines was held in March 2002; a record of the consultation is provided at www.aciar.gov.au under Partner country priorities/Philippines.

In 2005–06, new projects will be considered in the areas of farming systems and agricultural economics, fisheries, postharvest technology and management of land and water resources, with priorities in those areas being:

Agricultural economics, marketing and policy

- Research and development interventions aimed at including agricultural productivity and production efficiency, including:
 - Analysis of market structures to increase smallholder profitability
 - Technical and policy research cooperation to increase the access of Philippine agricultural products in international markets
 - Domestic and international commodity production forecasting
- Policies and economic assessment of application of biotechnology in agriculture
- Assessment of different mechanisms for the delivery of extension services
- Application of information and mapping systems to assist in agricultural planning
- Valuation of environmental services for sustainability of agricultural production

Postharvest technology

- Application of biotechnologies for the improvement of horticultural crops and coconuts
- Development and application of diagnostic tools for major crop diseases
- Policy and regulatory standards for the management of pesticide residues and mycotoxins
- Optimisation of postharvest systems to improve utilisation of crops and byproducts
- Information modules to facilitate the uptake of crop production, protection and postharvest technologies

Fisheries

- Sustainable coastal aquaculture systems, including the integration of capture fishery and culture systems
- Technologies and policies to meet fishery product quality and safety requirements
- Development of improved surveillance and management capacity for economically important fisheries diseases
- Consolidation of available fisheries research knowledge for use by smallholders, extensionists and educators

Land and water resources management

- Promotion of sustainable agricultural production through natural resources management R&D
- Research to underpin policies for management of groundwater
- Technical and economic analysis of the irrigation requirements of high-value fruit and forest tree plantings
- Improved cropping and agroforestry options and land management systems for marginal and hilly lands
- Improved adoption of soil fertility management and soil and water conservation strategies at the watershed level

Program Adviser

Dr John Skerritt

Key program managers

Dr Ken Menz, Agricultural Systems Economics and Management

Mr Barney Smith, Fisheries

Dr Ian Willett, Land and Water Resources

Dr Greg Johnson, Postharvest Technology

Country Manager

Ms Cecilia Honrado, ACIAR Country Manager, Philippines

Active projects

at 30 June 2005

Bilateral

AH/2000/009	Development of diagnostic and control methodologies for animal trypanosomiasis (Surra) in Papua New Guinea, Indonesia, the Philippines and Australia	15
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ASEM/2003/011	Herbicide use strategies and weed management options in Filipino and Australian cropping	26
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FST/2000/127	Improvin and maintaining productivity of bamboo for quality timber and shoots in Australia and the Philippines	38
LPS/1998/025	Performance evaluation evaluation and genetic improvement of ruminant animal animals in the Philippines	40
LWR/2001/003	Integrated watershed management for sustainable soil and water resources management of the Inabanga watershed, Bohol Island, Philippines	42
LWR/2003/006	Enhancing agricultural production in the Philippines by sustainable use of shallow groundwater	44

PHT/1994/045	Control of ripening in papaya and mango by genetic engineering	46
PHT/1997/094	Management of postharvest diseases of sub-tropical and tropical fruit using their natural resistance mechanisms	48
PHT/2003/071	Integrated pest management and supply chain improvement for mangoes in Philippines and Australia	50
PHT/2005/017	Information, knowledge, and training gaps in the postharvest sector of the Philippines grain industry	51
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Multilateral		
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CP/2000/002	Development of advanced technologies for germplasm conservation of tropical fruit species	57
PLIA/2000/039	Impact of migration and/or off-farm employment on roles of women and appropriate technologies in Asian and Australian mixed farming systems	59

Project AH/2000/009: Development of diagnostic and control methodologies for animal trypanosomiasis (Surra) in Papua New Guinea, Indonesia, the Philippines and Australia

Overseas Collaborating Countries	Indonesia, Papua New Guinea, Philippines
Commissioned Organisation	Murdoch University, Australia
Project Leader	Dr Simon Reid Phone: 08 9360 7423 Fax: 08 9310 4144 Email: sreid@central.murdoch.edu.au
Collaborating Institutions	Research Institute for Veterinary Science, Indonesia Provincial Livestock Department, Irian Jaya, Indonesia National Agriculture and Quarantine Inspection Service, Papua New Guinea University of Southern Mindanao, Philippines Department of Agriculture, Region XI, Philippines Balai Penyidikan Penyakit, Sulawesi, Indonesia University of Western Sydney, Australia
Project Budget	\$399,880
Project Duration	01/01/2001 to 31/12/2005 (Project extended from 01/01/2004 to 31/12/2005)
ACIAR Research Program Manager	Dr Peter Rolfe

Project background and objectives

The disease of animal trypanosomiasis (or surra) is caused by the protozoan parasite *Trypanosoma evansi*, transmitted by biting tabanid flies (March flies). The result of infection is an acute or chronic wasting, depending on host susceptibility and the virulence of the parasite strain. Many animals can be afflicted, including livestock and horses. The disease is found in much of the world, including all of the Philippines and Indonesia. Evidence from antibodies in blood samples shows that *T. evansi* may be present in parts of Irian Jaya. However, it is believed that Australia and Papua New Guinea may no longer be free of this disease.

Recent research has shown that pigs and deer could be efficient reservoir hosts for the parasite. Pigs and two species of wallaby common to Papua New Guinea and northern Australia are believed to be highly susceptible to infection and suffer acute disease with a high mortality rate. Therefore if the disease is found in PNG or enters Australia, it would have a devastating effect on livestock and probably on many native marsupials.

This project will have a research focus on the impact of *T. evansi* on livestock and the determinants of clinical disease through a series of well-validated diagnostic tests. It will achieve effective ways of controlling *T. Evansi*, and transfer this technology to neighbouring countries to improve surveillance and reduce the risk of disease entry to Australia. Both Indonesia and the Philippines would like to establish control mechanisms to reduce livestock infection and improve productivity. This project therefore involves both countries, along with PNG and Australia, building on research into the parasite carried out at James Cook University, Townsville (ACIAR project AS1/1996/150).

Project progress

Year 4 (01/01/2004-31/12/2004)

Determine the socio-economic profile of surra in Mindanao

A workshop was held in Davao in September 2004 to provide training for project staff as well as veterinary staff from other regional offices who form part of the Mindanao Unified Surra Control Approach (MUSCA) program. Preliminary results from a field visit during the workshop showed that carabao are the most important livestock species and that their value is measured by their use as draft animals. If an outbreak of surra occurred mortality in carabao would significantly reduce the capacity of farmers to generate income and provide food from the production of cash crops.

Two preliminary surveys to determine the prevalence of infection with *T. evansi* in carabao have been performed in a region of Mindanao, where there is no evidence of clinical surra (Bukidnon) and in a region that has experienced a recent outbreak of surra (Surigao del Norte). Results showed that there is a significant difference in the serological prevalence of infection between the two regions determined. The prevalence of parasitaemia with *T. evansi* in Surigao del Norte was high (12.5%), which suggests that transmission of *T. evansi* is still occurring despite intensive use of trypanocidal drugs in the area with Diminazine aceturate (Trypan).

Determine the efficacy of cymelarsan for the treatment of chronic *T. evansi* infection

An experiment was conducted at Balitvet to re-evaluate if different isolates of *T. evansi* from Indonesia vary in their susceptibility to cymelarsan. A series of experiments conducted as part of the original AS1/2000/009 was unable to unequivocally prove this mainly because of the need to use small experimental groups (5). The results show that there is no significant difference between the sensitivity of each of three isolates of *T. evansi* to cymelarsan. This is important because it suggests that Indonesian isolates of *T. evansi* are likely to be reasonably homogeneous in their susceptibility to treatment with cymelarsan.

Project AS2/1999/060: Control of bees and bee mites in Indonesia and the Philippines

Overseas Collaborating Countries	Indonesia, Philippines
Commissioned Organisation	CSIRO Entomology, Australia
Project Leader	Dr Denis Anderson Phone: 02 6246 4148 Fax: 02 6246 4173 Email: Denis.Anderson@ento.csiro.au
Collaborating Institutions	National Beekeeping Centre, Perum Perhutani, Indonesia Don Mariano Marcos Memorial State University, Philippines Dinas Peternakan Propinsi Dati I, Indonesia University of the Philippines at Los Banos, Philippines
Project Budget	\$580,206
Project Duration	01/07/2001 to 30/06/2005 (Project extended from 01/07/2004 to 30/06/2005)
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

In the late 1970s and early 1980s, colonies of the Asian hive bee *Apis cerana* and the European honey bee *Apis mellifera* were introduced to Irian Jaya from Java. The Asian bees brought with them the parasitic mite *Varroa jacobsoni*, while the European honey bees introduced another parasitic bee mite, *Tropilaelaps clareae*.

This raised concerns that the mites would eventually spread to the main beekeeping areas of Papua New Guinea (PNG) and destroy the fledgling beekeeping industry that was based on *A. mellifera* and also that they could spread to Australia by 'island-hopping' through Torres Strait. The establishment of these pests in Australia would have a severe environmental impact, would result in significant losses to the local beekeeping industry and would disrupt pollination services worth over \$1 billion per annum. Hence, an ACIAR project (AS2/1990/028) was initiated in 1991 to gain information about the bee and mites in PNG. That project was followed by two further projects, one in PNG (AS2/1994/018), and another that extended the research into Irian Jaya (AS2/1994/017). Each project gained valuable insights into the bee and bee mite problem, not only in Papua New Guinea, but world-wide.

There is still a strong demand in parts of Asia, such as Indonesia and the Philippines, for cheap and effective ways of controlling parasitic Asian bee mites. The recent encroachment of Asian bee mites towards Australia has also highlighted the need for further information on the mites and their bee hosts in order to improve local quarantine efforts and to establish a 'state of preparedness' should a breach in quarantine occur. This project is therefore designed to find out more about the problem, the mites, and reliable, cheap methods of control.

Formic acid is already being used for controlling bee mites in Europe and the United States. Research indicates that low concentrations of formic acid can be used effectively to control bee mites, whilst posing little danger to human health. This method is cheap, safe and effective and is ideally suited to smallholder beekeepers, with may be adopted quickly. This project will test and adapt this technology for use in Indonesia and the Philippines where formic acid is readily available.

Project progress

Year 4 (01/07/2004-30/06/2005)

During the past year experiments were completed on testing formic acid (FA) as a possible inexpensive means of controlling parasitic bee mites on European honeybees (*Apis mellifera*) in Indonesia and the Philippines. In the lead-up to these experiments laboratory results had indicated that FA was very lethal to bee mites and that it might be possible to use it as an effective control agent at low concentrations (15% or 30%) in entire hived bee colonies, provided that air-flow inside the hives could be improved (to improve FA dispersion) and that the treatments could be prolonged without harming the bees (to allow longer contact between the FA and mites). A system of delivering the FA to bee hives that met these criteria was subsequently developed and used during the past year by a Philippine collaborating organisation (DMMMSU) to test the effectiveness of both high and low concentrations of FA in controlling *Varroa destructor* in hived bee colonies. All concentrations of

the acid tested were found to be very effective in ridding colonies of *V. destructor*, both from the bodies of adult bees and from the bees' capped brood cells. The level of control achieved was also comparable with that obtained using Apistan®, a relatively expensive chemical acaricide used for controlling bee mites in Western countries. Nevertheless, only relatively low concentrations of the acid were found suitable for use in the new delivery system, as the use of higher concentrations led to some harmful side effects to the bee colonies. Similar results to these were also obtained by one of the Indonesian collaborating organisations (Perum Perhutani) using the same delivery system. Hence, beekeepers in the Philippines and Indonesia are now being encouraged and educated to use FA as part of their mite management practices. The recommended treatment for a single hive with mites is 2 applications, each of 3 litres of 15% FA (in water) delivered to hives via the new delivery system, with the second application given 2 weeks after the first application.

In past year, studies were also completed on the genetic variation among different populations of the small Asian bee *Apis cerana* and their parasitic *Varroa* mites, and among different populations of the giant Asian bee *Apis dorsata* and their parasitic *Tropilaelaps* mites. While conducting these studies, information was also gathered on the identity of *Varroa* and *Tropilaelaps* mites that are harmful to European honeybees. The studies involved analysing DNA sequences obtained from large numbers of bee and mite isolates. In brief, the results showed that the species *A. cerana* consists of many different genotypes each of which hosts a particular genotype of *Varroa* mite. Only 2 *A. cerana* genotypes host *Varroa* mites that are harmful to the European honeybee. The species *A. dorsata* also consists of many genotypes each of which hosts a particular genotype of *Tropilaelaps* mite. Most of these *Tropilaelaps* genotypes are harmful to the European honeybee. As part of this work, methods were devised that now enable each bee and mite genotype to be easily and cheaply identified.

Significant details of the *A. dorsata/Tropilaelaps* genetic variation studies have only come to light during the past year. Each *A. dorsata* genotype detected fell into one of 2 broad genetic groups of bees that corresponded to the previously recognised 'yellow bees' of Indonesia/Mainland Asia and the 'black-and-white bees' of Philippines/Sulawesi. The black-and-white bees were found to host different genotypes of *Tropilaelaps clareae*, while the yellow bees hosted *Tropilaelaps* genotypes that appear different from any previously described species. These yellow bees also carried different genotypes of *T. koenigerum*, some of which were detected in countries from which the mite had not been previously reported. All genotypes of *T. clareae* and of the seemingly new *Tropilaelaps* species from the yellow *A. dorsata* bees were found to be harmful to European honeybees, while *T. koenigerum* appears harmless to that bee.

While carrying out the genetic variation studies on *A. dorsata* and their *Tropilaelaps* mites, a previously undescribed species of *Tropilaelaps* was also isolated from the giant Asian rock bee, *A. laboriosa*. This mite appears to be harmless to European honeybees.

Project ASEM/2000/107: Future prospects for smallholder poultry producers in the Philippines: ducks and native chickens

Overseas Collaborating Countries	Philippines
Commissioned Organisation	University of New England, School of Agricultural & Resource Economics, Australia
Project Leader	Dr Christie Chang Phone: 02 6773 2855 Fax: 02 6773 3596 Email: hchang@metz.une.edu.au
Collaborating Institutions	University of the Philippines at Los Banos, Institute of Animal Science, Philippines
Project Budget	\$235,789
Project Duration	01/01/2002 to 31/12/2005 (Project extended from 01/01/2004 to 31/12/2005)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

The Philippine poultry industry meets about 95 per cent of local demand for chicken and duck products and is steadily expanding. There are four main subsectors of the industry — broiler chickens, layer chickens, native chickens and ducks. The commercial (broiler and layer) chicken farms are large-scale, highly advanced, geographically concentrated and integrated, with efficient marketing. Native chickens and ducks, on the other hand, are produced mainly through a large number of geographically diverse, small-scale, backyard enterprises, and marketing tends to be much less efficient. However, native chickens and ducks have a competitive advantage because of strong consumer preferences for their freshness and taste.

As trade liberalisation continues, the Philippine poultry industry is likely to face increasing competition from overseas and from other rival products. To survive and grow, the industry must be able to compete in the global market. The impacts of trade liberalisation are likely to vary between different subsectors, but are expected to have a greater effect on smallholders because of their size and relative inefficiency. This project will look at the relative competitiveness of the four poultry subsectors, how they are likely to be affected by international trade agreements and how smallholder production could be improved in anticipation of further trade liberalisation. To achieve this the project is studying production and marketing systems of the poultry industry, in order to identify constraints to, and opportunities for, improving the performance of smallholder poultry production. This will help smallholders to survive the effects of trade liberalisation.

Project progress

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

Cross-sector comparisons of poultry production in the Philippines: The study compared the commercial and backyard poultry sectors and identified key issues facing the two sectors. It was found that the poultry industry worldwide has enjoyed a strong demand growth because its relatively low cost and seen as healthy. The outlook is also positive for the Philippine given its current low level of per capita consumption and anticipated growth in population and household incomes. However, some of the future demand increase in poultry consumption is likely to be met by cheaper imports. And, like many other poultry sectors in the world, the Philippine poultry industry faces increasing consumer concerns over food safety, product quality and animal welfare, as well as environmental impact associated with intensive poultry production. There is also increasing global competition due to trade liberalisation. In addition, the Philippine commercial poultry sector was found to be relatively uncompetitive because of higher input costs, below-par on-farm productivity, and an inefficient marketing system, while the key issues facing the backyard poultry sector were variable product quality and inconsistent supply as a result of high degree of farm diversity and production seasonality.

The study also found that trade liberalisation is likely to affect both the commercial and the backyard sectors, although to varying degrees. For continuing growth, the Philippine poultry industry as a whole must pursue improvements in production and marketing efficiency and the government must provide an environment that is conducive to investment and productivity improvements. More direct government involvement appears to be desirable, especially in areas such as product grading and standard setting, collection and dissemination of market information, and improving roads and other marketing infrastructure.

The Philippine duck industry — issues and research needs: The study provided an overview of the duck industry and identified key policy issues and areas for further research. The main finding was that in the short to medium term, demand for duck products, including balut, may increase with income and population growth, but in the longer term it will decline as the economy develops further. This proposition is based on overseas experiences and demand trends in the Philippines.

A second threat facing the Philippine duck sector is foreign competition. Given its current industry structure (less developed and fragmented), the Philippine duck sector does appear to be vulnerable even though currently imports account for only a small proportion of total supply. How the Philippine duck sector can withstand the test of trade liberalisation depends on its ability to address the key issue of an inefficient marketing system. This inefficiency is a result of a fragmented industry structure, the absence of official product standards and inadequate marketing infrastructure. Although the increasing trend in the commercialisation of duck production may help improve production and marketing efficiency due to economies of scale, smallholders are likely to be adversely affected by such developments in terms of reduced market access and farm prices.

Based on these findings, two main policy recommendations were put forward:

- more research is needed to identify production and marketing issues facing the smallholders and to understand future consumer demand for duck products; and
- official product standards and reliable market information are needed to correct market failures and improve marketing efficiency.

Farm survey of duck producers

Two hundred and thirty four duck egg producers in Iloilo, Nueva Ecija, Pampanga and Queson provinces were surveyed. Farmers were asked about their demographic and farm characteristics, their income sources and problems encountered in the production and marketing of duck eggs, as well as their awareness of, and participation in, farm organisations and government programs.

Highlights of the preliminary results are as follows:

- 84 per cent of the respondents were involved in rice/crop farming or duck farming,
- 14 per cent of the respondents were classified as backyard (1-99 birds), 35 per cent as small commercial (100-499 birds), 21 per cent as medium commercial (500-999 birds) and 29 per cent as large commercial (= 1000),
- 37 per cent of the respondents also raised other poultry, 38 per cent also raised pigs, 18 per cent also raised other livestock,
- 75 per cent of the respondents said that it was buyers (viajeros, balutans, retailer) who provided price information and determined prices, and
- 66 per cent of the respondents used their own capital while 28 per cent had borrowed from outside; the main sources of capital came from relatives and informal sources (63 per cent) and traders/suppliers (20 per cent); only 15 per cent borrowed from the banks.

Project ASEM/2001/108: Improving delivery of extension services in the Philippines

Overseas Collaborating Countries	Philippines
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Collaborating Institutions	University of the Philippines, Diliman, Center for Local and Regional Governance, Philippines
Project Budget	\$398,278
Project Duration	01/01/2003 to 31/12/2005
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

In the Philippines, agricultural productivity improvements since the 1960s have been slow in coming. The public delivery of extension services has largely devolved to provinces, cities, municipalities and villages as a result of the 1991 Devolution of Powers Act. Thus, answers to questions of the relative roles of private and public extension services and the financing and delivery of public extension are important. Project researchers are helping to answer these questions by defining the respective roles of public and private extension services in the Philippines. This includes the development of an economic framework for the financing, design and delivery of public extension services to farmers from central to local government level. Practical steps for adopting such a framework will then be proposed.

Project progress

Year 2 (01/01/2004-31/12/2004)

Agricultural extension which is one way of improving productivity has undergone substantial change in the last thirteen years through devolution under the local government code. Whether devolution has improved agricultural extension delivery is a key question. Devolution generally, has yielded some positives; cooperation between LGUs and with the private sector and NGOs, recognition of the realities of globalization and use of modern management and communication. But problems remain.

Devolution, what has happened? When services were devolved, people recognised there were risks. On the one hand there were potential gains from local participation, and on the other hand there were risks of weak capacity and political patronage. This story is emerging from the case studies.

Farmers as clients: One of the potential benefits of devolution was the greater empowerment of farmers by putting them closer to service providers. So a particular aspect of devolution and public extension delivery in general has to be from the point of view of farmers as clients. The main obstacles are:

- farmers are too small and a combination of land reform law constraints, weak tenure and weak finance tends to keep them small,
- public policy pushes people towards rice growing which keeps them poor and diminishes interest in their own profitability, and
- on the supply side, delivery of extension suffers from overlap of central government departments and local government so that even if farmers were able to 'voice' their needs they would not be listened to.

Conference papers: One of the main themes has to do with policy response. Various recent reports on extension tend to focus on the supply side. Thus they argue for unification of extension program and agenda, better technical training of extension staff and a better interface of extension and

research. An emerging counter proposition is that until farmers become effective clients, unification and strengthening of supply is unlikely to be effective.

What to do to give farmers a voice: There are several possibilities:

- address central policies of self sufficiency and land tenure,
- move to co-payments, vouchers and other like options, and
- Learn from the Australian experience where the various models all count on local participation and shared identification and resolution of needs. They all recognise that solutions imposed from above are bound to be ineffective:
 - group facilitation/empowerment,
 - technology development, and
 - information access.

Project ASEM/2002/051: Sustaining and growing landcare systems in the Philippines and Australia

Overseas Collaborating Countries	Philippines
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, , Australia
Project Leader	Noel Vock Phone: 07 5444 9614 Fax: 07 5441 2235 Email: noel.vock@dpi.qld.gov.au
Collaborating Institutions	University of Queensland, Australia SEAMEO Regional Centre for Graduate Study and Research in Agriculture, Philippines World Agroforestry Centre, Philippines Catholic Relief Services, Philippines
Project Budget	\$1,278,459
Project Duration	01/07/2004 to 30/06/2007
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Although Landcare systems were not introduced to the Philippines as part of an ACIAR project their development and growth were a key outcome of past ACIAR-supported research. The project helped facilitate the growth of Landcare at three nodes in Mindanao (Claveria, Lantapan and Ned). More than 400 groups have been established with up to 60 per cent of farmers in each location adopting some form of conservation farming. Farmers involved in Landcare reported positive impacts on productivity and profitability. Almost 50 Local Government Units and NGOs have also become actively involved. This success has seen the approach adopted by agencies involved in development activities in Mindanao. These agencies, and others operating elsewhere in the Philippines and beyond are requesting additional information on planning, implementation and evaluation. Adopting the Landcare approach as a means of addressing rural poverty in Mindanao is now also being examined.

There are, however, questions over the sustainability of Landcare in the longer term and if the success at the three sites can be replicated elsewhere in Mindanao and beyond into the Visayas. Creating linkages to broader Landcare networks will be an aim, to help broaden the reach of the program. The role of Landcare in southeast Queensland will also be examined, following the previous project including a component examining Landcare in horticulture industries in Queensland. This revealed the spread of urbanisation in the southeast of the state was creating additional pressures for agriculture. The environmental imperatives on farmers in peri-urban areas, close to major waterways and tourism areas are growing. The effectiveness of Landcare in helping the horticulture industry in southeast Queensland to improve its viability and sustainability will also be examined. The Philippines component is improving the standard of living, social capital and environmental stewardship of poor rural communities in the southern Philippines, through:

- implementing, sustaining, and scaling-up effective landcare practices and the associated institutional structures and processes within selected vulnerable landscapes, and
- analysing and evaluating the appropriateness of models used to sustain and scale-up landcare processes.

Project progress

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

In the Philippines component, progress against the objective of strengthening institutional support structures for Landcare included establishing a working partnership with the Landcare Foundation of the Philippines Inc (LFPI), and with the Landcare Coordinators Network (LCN). Opinions on existing institutional support structures for natural resource management within government, civil society and

private industry sectors was undertaken to identify possible case studies of appropriate issues for a successful Landcare agency.

Existing municipal Landcare associations and other local structures at the three existing sites of Misamis Oriental, Bukidnon and South Cotabato were strengthened through:

- at **Misamis Oriental** a re-scoping of institutions and issues across the province, and
- development and implementation of a strategy to focus efforts on five core sites across the province – the well-established Landcare sites of Claveria and Malitbog as key learning and innovation sites, and three strategically-located satellite learning sites in Alubijid, Sugbongcogon and Kinoguitan,
- at **Bukidnon** the development and implementation of a strategy to focus efforts on five core sites across the province – the municipality of Lantapan; re-invigorating the Landcare programs in the municipalities of Manolo Fortich and Malaybalay City; and developing new programs in one or two new municipalities where factors conducive to Landcare exist,
- focusing the main effort on building and enhancing the effective Landcare capacity of both Landcare institutions (such as the Lantapan Land Care Association, Farmer Training Group, and LFPI) and the local and provincial governments, and
- maintaining a watching brief on potential Landcare scaling-out sites in neighbouring provinces to the south and west of Bukidnon.
- at **South Cotabato** a similar process of developing and implementing a strategy to enhance the Landcare structures and processes established during the previous project at the Barangay Ned site,
- scaling-out Landcare to the province of South Cotabato through targeting a small number of strategically-important upland municipalities near the Mt. Matutum, Mt. Parker and Mt. Roxas mountain ranges, and
- building partnerships with, and enhance the effective Landcare capacity of, LGUs, Landcare institutions and NGOs.

Initiation of effective Landcare programs in the new sites of Bohol and Agusan del Sur was furthered through:

- at **Bohol** scoping of the site with meetings with key stakeholders, and identification of appropriate entry points and engagement processes,
- identification of two priority project sites — the Carood watershed and San Isidro, and the further investigation of four other sites (Carmen, Danao, Dagohoy and Sagbayan), and
- development of partnerships with a number of LGUs and NGOs, and preliminary site engagement.
- at **Agusan del Sur** scoping of the site with collection and review of data, mapping of key players in the province, and courtesy visits to key players,
- identification of six municipalities as key focus areas – three in the upper part of the province (Bayugan, Esperansa and Sibagat), and three in the lower part (Bunawan, Trento and Sta. Josefa), and
- development of partnerships with the municipal LGU and other institutions, and preliminary site engagement.

Sustaining and scaling up adoption of conservation farming systems and diversified livelihoods:

Thirty-two major training, capacity building and networking events were held across the five sites, facilitating the provision of information and support services to improve productivity, diversification and resource sustainability of member farms.

Analysing and evaluating impacts: A broad research infrastructure and research process was established with project staff receiving complementary training. A minimum set of baseline information was developed, along with a list of site research topics and individual site process documentation priorities.

Project ASEM/2003/009: Bridging the gap between seasonal climate forecasts and decision makers in agriculture

Overseas Collaborating Countries	Philippines
Commissioned Organisation	South Australian Research and Development Institute, Climate Risk Management Unit, Australia
Project Leader	Peter Hayman Phone: 08 8431 6926 Fax: 08 8303 9424 Email: hayman.peter@saugov.sa.gov.au
Collaborating Institutions	Philippine Atmospheric, Geophysical and Astronomical Services Administration, Philippines Philippine Institute for Development Studies, Philippines Leyte State University, Philippines University of Sydney, Australia NSW Department of Primary Industries, Australia
Project Budget	\$833,015
Project Duration	01/01/2005 to 31/12/2008
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Climate variability is particularly problematic in rainfed agricultural systems, such as those found in the Philippines and eastern Australia. One main cause of variability in both countries is the El Niño Southern Oscillation (ENSO). The ENSO phenomenon causes higher season-to-season variability relative to other regions at the same latitude. This variability causes difficulty for farmers in decisions regarding planning and managing seasonal activities. Drier seasons result from ENSO events, often dramatically reducing productivity in many systems, especially cropping. Longer ENSO events can lead to drought. For farmers this can also result in the adoption of more conservative mind-sets, with a reduced willingness to take risks, both real and perceived (such as planting a previously untried variety that may be well suited to drier conditions).

Forecasting based on ENSO indicators can be developed on a seasonal-scale. The Philippines meteorological service (PAGASA) issues climate forecasts based on recently developed ENSO knowledge. Despite this questions remain over the value of seasonal climate forecasting (SCF) amongst farmers and policy-makers. Users of SCF have yet to adequately integrate forecasting identifying rainfall odds, based on ENSO, as all uncertainty is not eliminated. A framework that helps them to address such concerns is needed, to build end-user confidence into using and integrating SCF decision-making. The framework is being established to:

- improve the capacity of PAGASA to develop and deliver SCF,
- distil key practical and methodological features of economic and psychological approaches to valuing SCF,
- estimate the potential economic value of SCF for farm and policy or industry level case studies in the Philippines and Australia,
- identify those factors leading to a gap between actual and potential values of SCF, and
- develop and implement strategies to better match forecasts with decision maker's needs.

Project progress

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

The first progress report is due in 2006.

Project ASEM/2003/011: Herbicide use strategies and weed management options in Filipino and Australian cropping

Overseas Collaborating Countries	Philippines
Commissioned Organisation	University of Western Australia, School of Agricultural and Resource Economics, Australia
Project Leader	Dr Rick Llewellyn Phone: 08 6488 3419 Fax: 08 6488 7870 Email: rllewell@agric.uwa.edu.au
Collaborating Institutions	Philippine Rice Research Institute, Philippines
Project Budget	\$388,331
Project Duration	01/07/2004 to 30/06/2008
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Weed management in the Philippine's rice sector is increasingly being linked to the use of herbicides. These are being used because of changes from traditional approaches to growing, where seedlings are grown then transplanted into paddies. Increasing economic and environmental factors are resulting in direct seeding taking over from transplanting. Water availability is a key issue, the less water the greater imperative to direct seed. At the same time labour costs have risen, this being a key input in transplanting rice, requiring 50 per cent more labour. Herbicide costs, another key input into direct seeding have fallen. Traditional approaches using transplanting have, as a result of increased costs, been replaced in many areas by direct seeding. Almost half (44 per cent) of all rice is now grown by direct seeding. The main drawback to this system is weeds and their control. Traditional practices utilise Integrated Weed Management but direct seeding, requiring less water and flooding, offers greater opportunities for weed establishment.

The main form of weed control now used for direct seeding is herbicides. Without their use direct seeding is not viable, with yield losses from uncontrolled weeds at between 45 – 95 per cent. Experience in other countries shows that if not properly managed herbicide use can lead to resistance in weeds. Once resistance is established herbicide options can quickly become limited, making direct seeding all but impossible. Acting during the early stages of resistance build-up is the best option against resistance reaching uncontrollable levels. Weed management options, based on scenarios and modelling will be examined in both the Philippines and Australia, including by:

- sampling and documenting farmers' current weed practices, perceptions and information sources in relation to direct-seeded rice,
- testing, evaluating and adapting a promising (low herbicide use) direct seeded rice production method in farmers' fields through farmer participation, and
- assessing the status of herbicide resistance in rice weeds in the Philippines.

Project progress

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

Sample and document farmer's current weed management practices, perceptions and information sources: A survey was designed and implemented in two major rice growing areas, Nueva Ecija and Iloilo, where direct-seeding is used intensively. Preliminary results show that farmers used a combination of cultural practices and herbicides to manage weeds. Land levelling is the most common cultural practice in both provinces. Almost all farmers used herbicides at least once per season or twice per year. The usage of herbicides from herbicide groups known to have high risk of resistance development is increasing in both provinces. Farmers have little or no knowledge of herbicide resistance. Farmers are concerned about the environmental impact and health hazards associated with herbicide usage.

Test, evaluate and adapt a promising (low herbicide) direct seeded rice production method:

Participatory on-farm trials have been established in four sites (Rizal and Aliaga in Nueva Ecija in Central Luzon and Barotac Nuevo and Dingle in Iloilo in the Western Visayas). The trials have tested an integrated weed management (IWM) strategy consisting of a combination of good land preparation, intermittent water management, and single herbicide application of a pre- or early post-emergence herbicide. The IWM trial was tested side-by-side with the farmers' current weed management practice. Results obtained from the four sites for the first cropping season were consistent in indicating a better weed control, increased yields, and higher profits are associated with the use of integrated weed management as compared to current practice.

Assess the status of herbicide resistance in rice weeds: Regional awareness of herbicide resistance risks and avenues to report suspected populations has been raised through Philrice extension networks. Preliminary results of the first screening for herbicide resistance of eight populations of *Echinochloa crusgalli* and *E. glabrescens* taken from the four project sites indicated possible resistance to butachlor + propanil herbicide. The screening is currently being repeated to confirm the observation.

Develop an economic framework for policy analysis of herbicide resistance and weed management issues in the Philippines and Australia: A study has been completed on the economics of pre-emptive management by farmers to conserve the herbicide glyphosate and published in *Crop Protection* (Weersink, Llewellyn & Pannell 2005). An initial literature review looking at issues related to conservation of the herbicide resource (particularly from a public good aspect), and modelling approaches that have been used to investigate this, has been completed. It is considered that the conservation of some herbicides and herbicide uses can have a public good component, particularly when the herbicide supports environmentally-beneficial practices and/or herbicide resistance can spread due to weed mobility.

Project ASEM/2003/052: Improving financial returns to smallholder tree farmers in the Philippines

Overseas Collaborating Countries	Philippines
Commissioned Organisation	University of Queensland, School of Natural and Rural Systems Management, Australia
Project Leader	Dr John Herbohn Phone: 07 5460 1646 Fax: 07 5460 1324 Email: j.herbohn@uq.edu.au
Collaborating Institutions	Leyte State University, Philippines Department of Environment and Natural Resources, Philippines Southern Cross University, Australia
Project Budget	\$698,128
Project Duration	01/01/2005 to 31/12/2007
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

In the province of Leyte, as elsewhere in the Philippines, forest industry development is considered a priority. Economically forestry is a viable industry for many farmers, particularly if underutilised land is used. Knowledge of market demands is also needed by smallholders to better deliver in-demand products. Most of the land farmed by smallholders is marginal and sloping with few other uses. With areas of the province deforested, or at best marginally productive, forestry and agroforestry addresses a second need, positive environmental management. Pressure to log native forests, in turn increasing deforestation, can be relieved through greater smallholder involvement. Most plantings are undertaken for production forestry and conservation.

In Leyte forestry does not meet provincial demand for timber, this being met by importing logs. Smallholders and community forestry practitioners rely on timber for on-farm and household use, but less so as a supplementary income. Past ACIAR research has demonstrated greater financial returns are possible if these two groups had better market access and knowledge of prices. This would likely result in the planting of appropriate species to meet timber demand, greater volumes being produced per unit of cost and improved log size and quality. Barriers to market entry, including improved registration processes through the Department of Environment and Natural Resources also exist and will be a focal point of project activities. A strategy to improve financial returns to existing tree farmers and intending smallholder tree farmers is being implemented, to:

- assist DENR to overcome policy constraints to tree registration and log transport,
- assist smallholder tree growers to satisfy market requirements and improve productivity, and
- identify and promote livelihood systems and policies which incorporate forestry and recognise the socio-economic circumstances of smallholders.

Project progress

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

The first progress report is due in 2006.

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

Overseas Collaborating Countries	Indonesia, Papua New Guinea, Philippines, Vietnam
Commissioned Organisation	University of Queensland, School of Land and Food, Australia
Project Leader	Dr Steve Adkins Phone: 07 3365 2072 Fax: 07 3365 1177 Email: s.adkins@mailbox.uq.edu.au
Collaborating Institutions	Philippine Coconut Authority, Philippines Cocoa and Coconut Research Institute, Papua New Guinea Research Institute for Coconut Palms, Indonesia University of the Philippines at Los Baños, Philippines Oil Plants Institute of Vietnam, Vietnam
Project Budget	\$711,309
Project Duration	01/07/2002 to 31/12/2005 (Project extended from 01/07/2005 to 31/12/2005)
ACIAR Research Program Manager	Mr John Cullen

Project background and objectives

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

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

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

Project progress

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

The physiological quality of the embryo used for tissue culture work is an important factor that, in part, determines the rate of seedling production from those embryos. Recent studies have shown that bigger embryos produce more healthy seedlings than the smaller ones. The efficiency of the embryo culture system has been further improved with a step that screens out all of the non-viable embryos from the tissue culture system after 6 to 10 weeks of culture. Reducing the medium carbohydrate load at the last seedling subculture step has been shown to have no negative effects on its subsequent growth but this action does reduce the chance of the seedlings becoming infected and performing poorly at a later stage of growth. Auxins applied at various times during the early steps of the embryo culture procedure were found to increase root production and this resulted in greater ex vitro seedling vigour. Removal of the haustorial tissue during the early steps of embryo culture was also able to improve seedling growth and ex vitro establishment. A simple acclimatization method, using a wooden box with a transparent plastic sheet lid, produced better quality seedlings than those produced using the traditional inverted plastic bag system presently used for seedling production.

Other results have shown that as early as 3 months into the in vitro culture procedure seedlings are capable of autotrophic growth if their roots are able to access a Hoaglands nutrient solution. However, the subsequent growth of these nutrient-nurtured seedlings was often slower than that seen for seedlings growing in the traditional way. Finally, CO₂ enrichment around young seedlings growing in nutrient solution, could promote seedling growth back to that seen in the control. This action was able to cut the time in vitro from 12 to about 3 or 4 months. This represents a massive saving in culture cost and time. Earlier work demonstrated that embryo transplantation is a possible method for producing seedlings from isolated embryos using surrogate nuts as nurturing hosts. This work, undertaken in Australia on poor quality supermarket nuts is now being repeated using quality fruit and embryos in Indonesia (ICOPRI). At this stage, there has been some difficulty in germinating the transplanted embryos in the surrogate host nuts with contamination hard to contain. A seed priming method is now being used to promote the germination of the transplanted embryo. At this stage >200 primed embryos of Palu Tall have been transplanted into either Mapanget Tall or Palu Tall.

Among inflorescence calli types identified, white, round and shiny, smooth surfaced ones are more likely to be highly embryogenic than rough surfaced, friable calli masses. Multiplication of these highly embryogenic calli masses is possible by cutting the cultures into smaller pieces and culturing them and doubling the casein hydrolysate concentration. ABA was found to be useful in promoting the formation of somatic embryos when applied 1 month later, to either on pointed structures or pointed embryos. These ABA-treated embryos showed further development when they were subcultured onto an ABA-free medium where they germinated at a rate of 4.5 per cent.

A protocol to test the genetic fidelity of plants coming from tissue culture has now been developed and used to study 20 clonal plants. Results indicate that the clones analysed in this project are genetically similar at the DNA nucleotide and methylation level following their production by somatic embryogenesis. Training was undertaken at UQ attended by three participants: from PNG, Dr. Pablito the Philippines and Vietnam. The training covered all of protocols used in all of the research programs of the project, with an emphasis placed on those used in the embryo culture program particularly the use a CO₂ fogging step to improve physiological health and growth of in vitro growing seedlings prior to their establishment in soil. Other training activities were also undertaken at OPI, ICOPRI Indonesia and PCA the Philippines.

Project CIM/2001/049: Development of PRSV-P resistant papaya genotypes by introgression of genes from wild *Carica* species

Overseas Collaborating Countries	Philippines
Commissioned Organisation	Griffith University, School of Biomolecular and Biomedical Science, Australia
Project Leader	Dr Rod Drew Phone: 07 38757292 Fax: 07 38757618 Email: R.Drew@mailbox.gu.edu.au
Collaborating Institutions	University of the Philippines at Los Banos, Institute of Plant Breeding, Philippines Bureau of Plant Industry, Department of Agriculture, Philippines
Project Budget	\$399,974
Project Duration	01/01/2002 to 31/12/2005 (Project extended from 01/01/2005 to 31/12/2005)
ACIAR Research Program Manager	Mr John Cullen

Project background and objectives

Papaya is the fourth most important tropical fruit crop, with five to six million tonnes produced worldwide each year. Production is threatened by the serious disease papaya ringspot virus form P (PRSV-P), a virus which is spread by aphids. This disease is rapidly spreading and devastating papaya production worldwide. Papaya is a major fruit crop of the Philippines and is used for local consumption as well as export. During the last 20 years PRSV-P has caused the closure of the whole papaya industry in some of the Philippines' island regions and has severely decreased production in many other areas. In Australia, where papaya production has been increasing steadily, the disease has been confined to Southeast Queensland. However, if the disease would transfer to North Queensland, where 80 per cent of production occurs, it would devastate the Australian industry.

Consequently, the development of resistant genotypes is a research priority in both countries. Resistant genotypes have been produced by genetic transformation, however there remains a consumer resistance to genetically modified fruit crops worldwide. The project is using traditional plant breeding systems to develop stable and fertile backcross lines of papaya that are resistant to the papaya ringspot virus form P (PRSV-P). These could and could be used as genetic stocks for papaya improvement. Elite genotypes of papaya are being developed for Australia and the Philippines which are resistant to PRSV-P, to trial on growers' properties. This project relies on the results of a previous project in which a fertile PRSV-P resistant hybrid between papaya (*Carica papaya*) and *C. quercifolia* was developed.

Project progress

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

Incorporation of PRSV-P resistance genes into elite papaya genotypes, using fertile resistant backcross plants: In Australia a tolerant papaya (from line 54) was field-tested for resistance. All second backcross (BC2) plants produced from line 54 eventually succumbed to PRSV-P after nine months in the field. There was, however, large variation between plants in terms of degrees of severity to the virus symptoms and time to develop symptoms (2 to 9 months).

In the Philippines Line 54 and BC2 plants produced from it have been susceptible to PRSV-P in the field. As in Australia, variation in rate and severity of symptom expression was observed.

Selection of backcross generations for PRSV-P resistance and good agronomic traits: A large number of BC2 plants between line 54 and other papaya genotypes were tested for PRSV-P resistance in Australia and the Philippines. All were susceptible to PRSV-P.

To determine agronomic traits of backcross plants, 1 row (34 plants) of 54 crossed to 2.001 and 1 row of 54 crossed to Solo were planted in the field in SE Qld. Plants of 54 x Solo and 2.001 x 54 showed good agronomic traits. Plants tended to be more like *C. papaya*. High yields, good fruit shape and size and high brix (the percentage of sugar) levels were recorded. Preliminary molecular marker analyses showed these plants had approx. two per cent quercifolia DNA. This suggests that only one or two more backcrosses would be needed to produce a commercial papaya.

Backcross fertile resistant C. papaya x V. quercifolia F1 hybrids to C. papaya: Backcrossing from five F1 hybrids that are PRSV-P resistant continues in Australia with some having pollen fertility. One hundred and thirty one BC1 plants are currently being screened for PRSV-P in the field. The first 50 plants have developed viral symptoms, again with differing degrees of severity. The other 81 clones are being monitored.

Six F1 intergeneric hybrid lines of *C. papaya* crossed with *V. quercifolia* from Australia were used as paternal parents to incorporate PRSV-P resistant gene/genes to five elite papaya inbred lines in the Philippines. Intergeneric hybrid lines had been extensively used in the backcrossing work. Pollen viability ranged from 1.2 to 2.2 per cent under Philippine conditions. The ratio of male flower in cross-pollinating female flower was increased from 10:1 to 20:1 to compensate the low pollen viability of the hybrids. To date, fifteen backcrosses were completed with varying success in terms of viable embryos produced. Nine hundred forty fruits were harvested in which 114,839 seeds were dissected under laboratory conditions. Ten backcrosses produced a total of 1011 embryos. Seven hundred and thirty three embryos had germinated into normal plantlets, each one was considered as a unique genotype.

Most of the genotypes were subjected to clonal micropropagation. Four hundred and twenty seven genotypes had been potted out and were evaluated for PRSV-P resistance in the screen-house. One genotype, showed putative resistance to PRSV after three mechanical inoculations. This was planted in the field, with its plant's to natural infection of PRSV monitored. It remained symptom and virus free after five months in the field. An enzyme-linked immunosorbent assay test confirmed the resistance of this promising genotype to the presence of PRSV. This putative resistant plant is a male tree and has 65 per cent pollen fertility. Backcrossing activities using pollen from this plant is in progress. In addition, 52 different interspecific hybrid plants were established in the field this year.

Development of molecular markers for PRSV-P resistance: Good progress has been made on mapping of *V. pubescens* and *V. parviflora* using RAF markers. A genetic map of the two species has been developed. Five molecular markers have been linked to PRSV-P resistance. Two of these have been sequenced, and a co-dominant SCAR marker has been developed from one.

Project CP/2005/035: Survey toolbox for plant pests - A practical manual for surveillance of agricultural crops and forests

Overseas Collaborating Countries	Cambodia, Indonesia, Philippines, Thailand, Vietnam
Commissioned Organisation	Department of Agriculture Fisheries and Forestry, Animal and Plant Health, Australia
Project Leader	Ms Lois Ransom Phone: 02 6271 5118 Fax: 02 6271 5835 Email: lois.ransom@daff.gov.au
Collaborating Institutions	Not applicable
Project Budget	\$100,000
Project Duration	01/01/2004 to 30/11/2005
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Increasing trade liberalisation has brought with it obligations for countries seeking WTO access. One of these is the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). This outlines domestic regulations for handling the presence of contaminants that may be found in traded commodities, including guidelines and international standards. Nowhere does this impact more than in the trade of agricultural commodities, the main export hope of many developing countries. The SPS Agreement requires countries to have well founded quarantine, technical and scientific capacities, areas in which most developing countries are under-resourced. Provision of a survey toolbox for plant pests will help in devising surveillance programs and other protocols to meet the requirements under the SPS Agreement.

Project progress

Year 1 (01/01/2004-31/12/2004)

- The initial table of contents were developed based on available literature.
- The proposal contents were then discussed at a workshop attended by the Reference Group. The Reference Group consisted of scientists from the Philippines, Papua New Guinea, Vietnam, Indonesia, Thailand, Fiji, Malaysia and across Australia. Observers from ACIAR and the co-funding body RIRDC also attended. The workshop was highly successful with relevant presentations and useful feedback and suggested improvements given. For example, it was agreed that the use of case studies were of great interest. Attendees identified relevant categories of surveys that would be most widely relevant and them volunteered to write the studies. Ideas about how the guideline structure and detailed entries might be improved were provided by all.
- Following the workshop, the ideas have been collated and worked in to a restructured table of contents which was sent electronically to the Reference Group for comments.

Project FIS/2002/019: Management and policy frameworks for illegal, unreported and unregulated (IUU) Fishing in Indonesian and Philippine waters

Overseas Collaborating Countries	Indonesia, Philippines
Commissioned Organisation	University of Wollongong, Centre for Maritime Policy, Australia
Project Leader	Professor Martin Tsamenyi Phone: 02 4221 3224 Fax: 02 4221 5544 Email: martin_tsamenyi@uow.edu.au
Collaborating Institutions	Department of Foreign Affairs, Maritime and Ocean Affairs Centre, Philippines Agency for Marine and Fisheries Research, Research Centre for Capture Fisheries, Indonesia
Project Budget	\$399,530
Project Duration	01/07/2003 to 30/06/2006
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Illegal, unreported and unregulated fishing is a major impediment to the sustainable management of fisheries. Effective fisheries management relies on accurate data collection, especially relating to fish catches and setting of catch quotas at sustainable levels. Without these forms of control, overfishing is likely and if continued will result in a collapse of a fishery.

In March 2001 the Food and Agriculture Organisation (FAO) Committee introduced the International Plan of Action to Prevent, Deter and Eliminate IUU Fishing. This plan requires FAO members to develop a National Plan of Action by October 2004. The FAO Plan calls for bilateral, regional and international cooperation to deal with IUU fishing. This is especially the case for shared fisheries that require coordination between countries.

One such shared fishery is the Sulawesi or Celebes Sea, shared by Indonesia and the Philippines. The key factors contributing to the IUU problem in the Sulawesi Sea include:

- Lack of agreement between Indonesia and Philippines on a maritime boundary;
- The complex administrative and legal structures (national, provincial and district interactions) on both sides of the Sulawesi Sea;
- The difficulties of harmonising management, administrative and policy measures across two national boundaries; and
- The high incidents of illegal foreign fishing activities in the area.

In addition to developing National Plans of Action, a cooperative framework between Indonesia and Philippines is required to comprehensively deal with the IUU fishing problem between the two countries because they share a number of fish stocks. Cooperation is, in fact, a significant requirement under the International Plan of Action on IUU Fishing. The groundwork for this has been established in a previous ACIAR project (FIS/2000/163), which initiated discussions between the two countries leading to a cooperative framework to tackle IUU fishing.

Another objective is to research the options for developing policy and management frameworks to deal with the extensive IUU fishing Indonesia and the Philippines, and in so doing, implement the outcomes of the 2001 ACIAR Small Project.

Project progress

Year 2 (01/07/2004-30/06/2005)

Despite the continuing security issues in Indonesia and Philippines, good progress was made in this project during 2004-05. The major goal of this research is to assist Indonesia and Philippines to develop the legislative and policy responses to help deal with IUU Fishing and encourage bilateral co-operation in areas that are subject to shared fish stocks.

Over the past 12 months, National IUU Fishing Workshops were held in Jakarta (Indonesia) and in General Santos City (Philippines). At each workshop, more than 50 participants discussed a range of

issues related to IUU Fishing and written presentations were prepared on key aspects, such as national fisheries profiles, data gathering, licensing systems, boat registration, legal frameworks, monitoring and compliance and FAO requirements.

Draft National Plans of Actions have been prepared in both countries and progress is now being made toward preparing the framework for bilateral cooperation.

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

Overseas Collaborating Countries	Indonesia, Philippines, Thailand, Vietnam
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Australia
Project Leader	Dr Mike Rimmer Phone: 07 4035 0109 Fax: 07 4035 6703 Email: Mike.Rimmer@dpi.qld.gov.au
Collaborating Institutions	Southeast Asian Fisheries Development Centre, Philippines Central Research Institute for Aquaculture, Indonesia Research Institute for Aquaculture No. 1, Vietnam Network of Aquaculture Centres in Asia Pacific, Thailand Sam Ratulangi University, Indonesia Research Institute for Coastal Aquaculture, Indonesia Gondol Research Institute for Mariculture, Indonesia CSIRO Marine Research, Australia
Project Budget	\$887,710
Project Duration	01/07/2004 to 31/12/2007
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

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

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

With marine finfish playing an important role in the economic well-being of many coastal communities, ensuring the sustainability of aquaculture is important to maintaining wild fisheries. Without such production fishing pressure on wild stocks will increase, fisher folk will increasingly be forced to trawl for trash fish and increasing numbers of wild fry and fingerlings will be removed from wild populations to act as a source of seed stock.

The overall objective of the project is to enhance the sustainability of marine finfish aquaculture in the Asia-Pacific region by improving hatchery production technology and facilitating the uptake of compounded feeds for grow-out.

Project progress

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

Many of the research activities of FIS/2002/077 have been delayed by various changes within the participating agencies. This has necessitated a major revision of the project, and has effectively delayed its implementation by 6–12 months.

Hatchery technology

Preliminary sampling has been carried out to assess the nutritional requirements of grouper larvae, and to identify the causes of the deformities that are commonly seen in hatchery-reared fish in Indonesia.

Grow-out feeds

Evaluation of the use of poultry offal silage meal to replace fishmeal in grouper diets indicated that the inclusion of poultry offal silage meal at rates up to 20% (equivalent to a 37% replacement of fish meal protein) had no significant effect on fish growth, survival or carcass composition of juvenile *E.*

fuscoguttatus. Higher levels of replacement may be beneficial but possible deficiencies of methionine, histidine and lysine may have to be overcome through the use of crystalline amino acids or complementary protein sources.

Digestibility studies to quantify the apparent dry matter, protein and lipid digestibility of six test feed ingredients, three of animal origin – poultry offal meal, golden snail and mysid meal – and three of plant origin – fine rice bran, maize meal and sorghum meal – have commenced at RICA Maros. For animal feed ingredients, the substitution rate is 40% while for plant feed ingredients, the substitution rate is 30%.

Asia-Pacific Marine Finfish Aquaculture Network

Extension and coordination activities, carried out through the Asia-Pacific Marine Finfish Aquaculture Network (APMFAN), have continued from the earlier grouper aquaculture project (FIS/97/73). Private sector support for APMFAN has been provided by Skretting, who provide support for the electronic publications (eNews and eMagazine) and are sponsoring four participants in the grouper hatchery training course over two years.

The results of FIS/97/73 were published as an ACIAR Monograph (no.110 – *Advances in Grouper Aquaculture*) and around 1,750 hard copies have been distributed and over 196 downloads of the electronic version recorded.

Two practical extension guides were produced:

- A Guide to Small-Scale Marine Finfish Hatchery Technology
- A Practical Guide to Feeds and Feed Management for Cultured Groupers

Around 150 hard copies of each have been distributed, and 1,364 and 870 downloads (respectively) of the electronic versions recorded. These two guides are currently in the process of translation into Indonesian, Thai and Vietnamese for distribution to farmers and investors in Asia.

Twenty-six issues of the APMFAN eNews were produced up to 30 June 2005, and three issues of the APMFAN eMagazine were produced. The distribution list for electronic publications is now around 1,088.

The 3rd Regional Grouper Hatchery Production Training Course was successfully carried out at the Brackishwater Aquaculture Development Centre, Situbondo, East Java, Indonesia from 18 April to 8 May 2005. There were participants from Australia, Brunei Darussalam, Indonesia, Malaysia, Maldives, Marshall Islands, Singapore, and Vietnam. Skretting sponsored a private sector participant from Vietnam as part of that company's support for APMFAN. APMFAN sponsored a fisheries officer from Aceh to participate in the training course as part of the capacity building for rebuilding the aquaculture sector in Aceh.

The first Study Program on Marine Aquaculture and Seafood Markets in Southern China (Guangzhou, Dayawan, Shenzhen, Shanwei, Yau Ping and Hong Kong) was successfully carried out from 4–15 July 2005 as an APMFAN activity. The Study Program was organised by the Network of Aquaculture Centres in Asia-Pacific (NACA), in cooperation with the Guangdong Provincial Bureau of Ocean and Fisheries, Guangdong Fishery Society, Guangdong Dayawan Fishery Development Center (Department of Marine and Aquatic Products, China), the Agriculture, Fisheries and Conservation Department (AFCD) – Hong Kong SAR. The Study Program introduced participants from exporting and producing regions in the Asia-Pacific area to the markets and marine aquaculture in southern China. There were 14 participants from China, Hong Kong, India, Indonesia, Maldives, Marshall Islands, Philippines, and Singapore.

The process of formalising participation in APMFAN is continuing. The Terms of Reference for Regional Resource Experts (RREs) and Regional Resource Centres (RRCs) have been developed (based on those developed for the NACA Aquatic Health Management Program) and an official letter has been sent to member governments.

Project FST/2000/127: Improving and maintaining productivity of bamboo for quality timber and shoots in Australia and the Philippines

Overseas Collaborating Countries	Philippines
Commissioned Organisation	Central Queensland University, Primary Industries Research Centre, Australia
Project Leader	Professor David Midmore Phone: 07 4930 9770 Fax: 07 4930 9255 Email: d.midmore@cqu.edu.au
Project Web Site	http://www.ahs.cqu.edu.au/info/science/psg/research/bamboo/
Collaborating Institutions	Parks and Wildlife Commission of the Northern Territory, Australia Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, Philippines Department of Primary Industries, Fisheries and Mines, Australia
Project Budget	\$399,479
Project Duration	01/01/2001 to 31/12/2006 (Project extended from 01/01/2004 to 31/12/2006)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Annual world trade in bamboo is worth about US\$4.5 billion (not including subsistence use). More than 80 per cent of the 1200 bamboo species, and most of the area in which bamboo grows, is in South and Southeast Asia. Only one species exists naturally in Australia and this needs further investigation for its plantation and food potential. The tall, straight bamboo stalks, known as culms, are used for timber or for paper pulping, while the fresh shoots are edible and widely used in some Asian cuisines. Newer uses are also being found, such as bamboo charcoal. Bamboos also offer good control of erosion on steep tropical land. Harvesting culms must be carefully managed. Inappropriate exploitation (for example, over-harvesting, especially of young culms) has depleted stands and resulted in a declining supply of timber in some places - particularly the Philippines.

After harvesting, fungal attack and the attentions of the powder-post beetle can cause damage to the product, particularly if the harvested culms contain starch. However, the starch content varies during the year. Harvesting when starch content is low will help minimise post-harvest losses, and research is needed to find out when this happens. The depletion of tropical forest reserves in the Philippines has caused a decline in wood production there, and an increase in the import of wood products. Part of this trade deficit can be alleviated and further deforestation prevented by substituting wood with bamboo. This is particularly important in poorer regions of the Philippines where the plant's shoots have the potential to improve human nutrition. The project is concentrating on maintaining and improving the productivity of existing bamboo stands through informed management, emphasising the production of constant high quality shoots for consumption, high productivity in managed plantations, and rehabilitating degenerated stands.

Project progress

Year 4 (01/01/2004-31/12/2004)

Rehabilitation of existing aged and/or damaged bamboo stands for shoots and timber: Three years ago (in 2001) experiments were established in the Philippines at Burgos, Ilocos Norte, at Cadagmayan Norte, Sta Barbara Iloilo and at Impalutao, Impasugong, Bukidnon, Malaybalay. The experiments at Burgos and Cadagmayan are for the investigation of the rehabilitation of natural stands of *Bambusa blumeana*, while the experiment in Impalutao is investigating the rehabilitation of a *Dendrocalamus asper* plantation that was established in 1986 and was previously managed. The experiment in Sta Barbara, Iloilo (which is situated in the cooperators' farms) consists of 25 old bamboo clumps of *Bambusa blumeana* with five treatments.

Harvesting of bamboo culms was done during the dry season (March-April) to facilitate ease of harvest and avoid/prevent powder-post beetle attack, the number of culms harvested (hereto referred as culm yield) of which were based on the treatments identified (relative to experiment uniformity). Data gathered may be indicative of the initial effects of these treatments but are still insufficient to make or infer conclusions and recommendations. The experiment at Impalutao, Impasugong, Bukidnon consists of ten treatments with three replicates. No clear trend regarding shoot production has been observed. However, based on the data gathered for this year, production of shoots increased with an average shoot production per clump of 7.4 as compared to last year's average shoot production per clump of only 3.8.

Maintenance of high productivity of existing plantations for shoots and timber: The 2004 shoot season is the fourth for the Philippine sites. The effects of irrigation, fertiliser treatments and density of culms per clump on the quality of *Bambusa blumeana* were more noticeable in the third year as the 3-year old culms were harvested for utilization. Initial results indicated that withholding irrigation and fertiliser on the clumps produced smaller poles but these tended to be of better quality for some specific finished products.

Shoot production was also monitored in the Dumarao experimental site. Shoot production in Dumarao for the year 2004 averaged 6.83 per clump. Based on the data gathered, early shoot season in the Dumarao site started as early as February and continued until June, with peak emergence during the month of April. The late shoot season started in late July until December for some clumps with the peak in August.

Improvement of bamboo timber harvest (efficiency and quality): Mean anatomical, chemical, physical and mechanical property data were recorded from *B. blumeana* culms collected from MMSU experiment in Batac, Ilocos Norte. The anatomical properties will determine the aptitude of the pole for various application (e.g. furniture, panel boards etc.).

The data for the anatomical, physical and mechanical properties of *B. blumeana* that had undergone two year treatment has been completed. The data for the chemical properties of *B. blumeana* that had undergone one year treatment has also been completed while those that have undergone the two year treatment are still in progress.

Bamboo database – production and marketing issues:

The researchers for this component interviewed 43 DOT-accredited hotels (deluxe, first class, standard and economy) and six restaurants in Metro Manila. Information on their bamboo shoot consumption, buying prices, and reasons for use or non-use were gathered. Some of these include the menu cycle, type of cuisine, preference of customer, and nationality of clients. Of the hotels surveyed, 19 used bamboo shoots while 24 did not. For the restaurants, four out of six included bamboo shoots in their menu while two did not.

Demand for engineered products has grown with orders from the Management Association of the Philippine (MAP) to supply the needs of government housing units that will be up for construction. Even a private construction company, the Mega World Condo Builders, has expressed interest in getting their engineered bamboo requirements from a project-related work group for 200 condominium units to be built by their firm. At least 50 per cent of the condominium's floor area will be built out of engineered bamboo.

The research team had provided inputs needed for the computation of the financial and market potentials of engineered bamboo as required in the ACIAR study. However, it was agreed by the group that the computation and analysis will depend on the product to be produced. An estimate of the production cost for a four pc. tray was done and this amounted to P400. The production cost, raw material requirements and other economic information for the other products are being estimated.

Project LPS/1998/025: Performance evaluation and genetic improvement of ruminant animals in the Philippines

Overseas Collaborating Countries	Philippines
Commissioned Organisation	University of New England, Agricultural Business Research Institute, Australia
Project Leader	Mr Arthur Rickards Phone: 02 6773 3555 Fax: 02 6772 5376 Email: arthur.rickards@abri.une.edu.au
Collaborating Institutions	Department of Agriculture, Philippines Animal Genetics and Breeding Unit, Australia
Project Budget	\$739,284
Project Duration	01/01/2000 to 30/06/2006 (Project extended from 01/01/2003 to 30/06/2006)
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

Agriculture is a major contributor to the Philippine economy, employing about 48 per cent of the workforce. The livestock industry accounts for more than a quarter of the agricultural sector, and there is a growing demand for livestock products to keep pace with the annual 2.3 per cent increase in the human population. Currently, the livestock industry relies heavily on pigs and poultry, with a rather poorly developed ruminant sector based mainly on smallholder farmers. Although the numbers of cattle (including buffalo) and goats have increased, productivity is low. For example, Philippine buffalo produce about 1.5 litres of milk per day compared with 8 litres for the imported Murrah buffaloes (and about 4.5 litres for the Murrah–Philippine Carabao crossbreed).

The main reason for this is indiscriminate crossbreeding by smallholder farmers, resulting in mongrel animals without the desired characteristics of a good herd. As village herds are small, it is not possible to achieve genetic improvement by breeding within them. The only way is a planned dissemination to village level of superior genes brought in to government herds, nucleus farms and multiplier herds. The Philippines Department of Agriculture is keen to improve the genetic quality of ruminants so that smallholder farmers can make greater profits. This project, run in collaboration with the Department, is helping ruminant industries to achieve substantial gains in productivity and income. The project is building capacity amongst the livestock scientists and administrators of the Philippines of modern genetic principles that will underpin the development of a national livestock genetic improvement program.

Project progress

Year 5 (01/01/2004-31/12/2004)

Work continued to focus on electronic capture of breeding and performance records to form databases that could be used in genetic evaluations. Some progress was made in capturing data from private farms to supplement that from the Bureau of Animal Industry's research herds.

The Animal Genetics and Breeding Unit (AGBU), Australia, released a report on the beef cattle database and provided genetic parameter files for the Philippines Brahman. These files were utilised in the first Philippines Brahman GROUP BREEDPLAN analysis that was undertaken in August. Two training courses were provided for beef breeders in the fourth quarter of 2004.

These courses provided an overview of BREEDPLAN and related technologies, technical presentations on the calculation of estimated breeding values and accuracy values, data quality and general BREEDPLAN procedures. Reports from the first Philippines Brahman GROUP BREEDPLAN analysis were provided to the managers of participating herds with results presented and discussed.

The small ruminant program concentrated on continued collection of pedigree and performance data. AGBU also took delivery of the small ruminant datasets from which they will be providing parameter estimates and genetic evaluation software.

The Agricultural Business Research Institute (ABRI), Australia, continued to develop the integrated pedigree/performance database for carabao. Datasets have been supplied by the Philippines Carabao Centre and combined into a prototype database held at ABRI. There have been significant developments of trait definitions and of the file layouts required to transfer data. AGBU provided a strategy for the Philippine carabao milk evaluation as well as details on the data structure they require for further testing.

The beef and small ruminant databases held at ABRI were transferred to the Bureau of Animal Industry (BAI) computer. Staff members of the BAI and the Philippines Carabao Centre were then trained in use of the integrated pedigree/performance software.

Project LWR/2001/003: Integrated watershed management for sustainable soil and water resources management of the Inabanga watershed, Bohol Island, Philippines

Overseas Collaborating Countries	Philippines
Commissioned Organisation	University of Western Sydney, School of Science, Food and Horticulture, Australia
Project Leader	Professor H. John Bavor Phone: (02) 4570 1264 Fax: 02 4570 1267 Email: j.bavor@uws.edu.au
Collaborating Institutions	Bureau of Soil and Water Management, Philippines Department of Environment and Natural Resources, Philippines
Project Budget	\$605,311
Project Duration	01/07/2002 to 30/06/2006 (Project extended from 01/07/2005 to 30/06/2006)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Bohol, the tenth largest island in the Philippines, is one of the country's most economically backward regions, with more than 80 per cent of the population dependent on agriculture. Poor land-use practices have caused soil erosion and runoff, leading to a decline in agricultural productivity. Bohol's fisheries and coastal mangroves have also been affected by these land degradation problems, as the quality and quantity of water in the rivers decline.

One of the most important sources of water for agriculture and domestic use in Bohol is the Inabanga watershed. The Inabanga watershed is the largest watershed in Bohol Island. There are plans to use the Inabanga River to provide the domestic water supply to Cebu, the Philippines' second largest city. The river is also necessary for planned agricultural and economic developments in Cebu. It is thus important to protect the Inabanga River; however, there is currently no quantitative information on soil erosion and runoff, and how these factors affect the quality and quantity of water in the river. This project is providing information needed to plan strategies for reversing damage to the land and water resources, and restoring agricultural productivity, to assist in developing strategies for reviving agricultural productivity in the Inabanga watershed in Bohol Island, Philippines, whilst protecting soil and water resources.

Project progress

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

Describe the current land and water resources: Maps have been completed showing the estimated current land-use areas that include six major agricultural crops (irrigated rice, rainfed rice, corn, cassava, coconut and oil palm) and forestry/grassland areas. The land-use cover percentages range from agriculture usage at 52 per cent to grassland and shrub land areas at 33 per cent, woodlands with 12 per cent, wetland areas at one per cent and miscellaneous/built up areas at one per cent. Watershed maps have been developed that show the area in three soil depth classes, slope maps in six different slope classes and a general erosion map in five different classes. The maps have been produced as stand-alone maps and also as GIS data-layers.

Technical information has been gathered and is being incorporated into a GIS framework and database to support better decision making via data and trend evaluation and modelling, applied to a wide variety of watershed management decision-making issues. Cropping and land-use suitability has been assessed in the watershed pedo-ecological zones with respect to soil type, with further evaluation incorporating specific agriculture practices, water source and slope characteristics. Local advisory teams provided technical assistance in capacity building to support the continuing transfer of education and training to sustain good agricultural practices, conserve soil and water resources, improve farming practices and increase farm income.

Evaluate the extent of soil erosion, sedimentation and water quality problems: Data have been gathered at the seven experimental erosion and runoff sites and three water sampling sites to determine runoff volume, water quality and soil loss under a wide variety of rainfall and cropping conditions experienced through the year. Data for nitrogen and phosphorus losses have also been determined. The sites include the following land-uses: agro-forestry, woodland, cassava/corn, grassland, rainfed rice, irrigated rice and oil palm. A GIS format and linked database have been compiled, with the data providing a rich source of information for planning agencies and NGO groups. It will soon be presented in farmer/community training activities.

Understand socio-economic and policy issues, and constraints that impact on the agricultural sustainability and surface water quality: A comprehensive dataset addressing agro-socio-economic issues in the watershed has been completed. The information has been gathered through farm surveys of 932 households from 114 barangays of 14 municipalities in 2000 and another 126 household in five municipalities in 2003. Also included were interviews and collected data from farmer-co-operators at 5 project sites. This has been achieved by the project team and personnel from several collaborating organizations (including the Department of Environment and Natural Resources (DENR) and PPDO) across the watershed. Some key results are high poverty levels, rising unemployment, low per capita income and farm productivity, with the exception of irrigated rice, which is below the national average.

Evaluate different options and impacts for water resources uses in the watershed: Alternative cropping scenarios and present/future water management practices have been considered in developing strategies to reduce sediment transport from agricultural activities, resulting in reduced crop production, degraded receiving waters and diminished water impoundment capacity. Through planned demonstration farms and learning centres, the team aims to create an enabling environment for stakeholders and others to protect and preserve watershed resources.

Enhance research capacity of staff in the BSWM/DENR and local collaborators: The project has used systems tools including GIS, GPS, remote sensing, modelling and simulation, and monitoring of runoff and soil erosion at the watershed scale to enhance research capability of the Bureau of Soil and Water Management and DENR and local collaborators. This has increased the team's experience and competency in watershed-scale data collection, monitoring and assessment and in-house capacity to model hydrology and soil erosion at watershed scale. Additionally, the Bureau's capability in geo-referencing and mapping soils, slope, elevation, land use and many other land attributes using GIS techniques, has been greatly enhanced.

Transfer research outputs to soil and water resources to stakeholders: A combined team effort, including many agencies and local stakeholders, has continued research efforts at both a local and watershed scale to understand the fundamentals of soil erosion and runoff, water quality evaluation, crop production and water management. This knowledge is being transferred, with the help of national level management agencies, local government, NGOs and community farmer groups.

Project LWR/2003/006: Enhancing agricultural production in the Philippines by sustainable use of shallow groundwater

Overseas Collaborating Countries	Philippines
Commissioned Organisation	CSIRO Land and Water, Australia
Project Leader	Dr Peter Dillon Phone: 08 8303-8714 Fax: 08 8303-8750 Email: peter.dillon@csiro.au
Collaborating Institutions	Bureau of Soils and Water Management, Philippines
Project Budget	\$399,790
Project Duration	01/07/2004 to 31/12/2007
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

In the Philippines most low-land agriculture is in part dependent on rainfall, which is usually abundant. Rainfall also recharges lowland aquifers, which are used to supplement rainfall in irrigated cropping. This combination of rain and recharging ensures sufficient water for production. In Ilocos Norte Province there are two seasons, dry from November to April and wet from May to October. The balance between these has, to date, been enough to ensure that groundwater levels remain sustainable. There is, however, a danger of groundwater overexploitation. High-value dry season crops — mung bean, onion, garlic and other vegetables — are increasing pressure for the use of groundwater. An instance of drought or prolonged reduced rainfall could dramatically increase such pressures. Exploitation can lead to crops failing, wells drying up, loss of base-flows from water courses, saline intrusion and in severe instances land subsidence. All would also impair farmers' productivity, both in the short and also long term, creating economic and social pressures.

Currently groundwater extraction is expensive, the main reason water use has remained at sustainable levels. Extraction relies on diesel-fuelled pumps, a fuel source likely to change as electricity generation becomes more widespread. Deeper-drilling pumps and increased awareness of the benefits and returns from groundwater irrigation will also increase extraction rates. Planning and development of management options before resources such as wells, mainly controlled by individuals, reach and exceed capacity is the best way to avoid exploitation and groundwater depletion. The longer this is left the less effective it is likely to be. Exploiting shallow groundwater sustainably, based on the project's findings, will increase crop production in lowland, rain-fed agricultural areas of the Philippines.

Project progress

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

Work on groundwater management within the Philippines has focussed on two pilot sites within neighbouring municipalities of the province of Ilocos Norte, namely Burgos and Pasuquin, which is located on the north-western tip of Luzon, Philippines. Activities within these two sites focused on assessment of groundwater supply and demand. This has involved examining groundwater condition and installation of monitoring systems that will be used to assess groundwater recharge and sustainable levels of groundwater use. This will help to determine the current level of groundwater use, and the current level of production of various crops within the region that might benefit from irrigation with groundwater.

Topographic surveys of the study area have been completed, and the locations of all existing shallow tube wells and dug wells have been mapped. Observation wells have been identified, their locations surveyed and monitoring has commenced. Water table and salinity maps have been prepared. Some preliminary groundwater sampling and water chemistry analysis has taken place, and further sampling is currently being carried out. Rain gauges have also been installed for collection of rainwater samples for chemical analysis. Comparison of rainfall and groundwater chemistry will permit

assessment of the rate of recharge to the aquifers. Geophysical surveys have been carried out to assist mapping of salinity distribution and stratigraphy.

The total number of wells currently used for groundwater within the region has been determined. The rate of extraction from each well has been estimated, and the existing use of the water determined. A socioeconomic survey has been completed, involving a total of 121 respondents. Areas currently planted to various crops have been determined on the basis of this survey. A soil survey of the region has also been completed, which will assist with determining land suitability for expansion of current areas of cropping.

A three-day workshop on Groundwater Investigation and Management was conducted in Ilocos Norte and attended by 25 staff from the Bureau of Soil and Water Management and other agencies involved with water management in the Philippines. The workshop concentrated on basic aquifer hydraulics (calculation of groundwater flow rates and flow directions from measurements of hydraulic head and hydraulic conductivity) and calculation of groundwater balances.

Project PHT/1994/045: Control of ripening in papaya and mango by genetic engineering

Overseas Collaborating Countries	Malaysia, Philippines
Commissioned Organisation	University of Queensland, Department of Botany, Australia
Project Leader	Dr Jose (Jimmy) Botella Phone: 07-33651128 Fax: 07-33651699 Email: Botella@botany.uq.edu.au
Collaborating Institutions	Malaysian Agricultural Research and Development Institute, Malaysia Queensland University of Technology, Australia University of the Philippines at Los Banos, Philippines Queensland Department of Primary Industries and Fisheries, Australia
Project Budget	\$951,654
Project Duration	01/07/1997 to 31/12/2005 (Project extended from 01/07/2004 to 31/12/2005)
ACIAR Research Program Manager	Dr Greg Johnson

Project background and objectives

All ASEAN countries, and Australia, produce papaya. It is a popular fruit, and exports to non-producing countries are increasing. It provides a cheap source of several vitamins and minerals. However, like most tropical fruits, papaya ripens quickly after harvesting and will then rapidly deteriorate and succumb to diseases. It is liable to soften and spoils easily. It is also sensitive to low temperatures and so cannot be stored in cool conditions. Transporting the fruit within a country — let alone exporting it — causes large losses. Up to 40 per cent of the harvest is lost in transit from the farmer to the consumer. Postharvest ripening and senescence (aging) are controlled mainly by the gas ethylene. This is given off by many fruit in increasing quantities as they mature. Papaya and mango produce their own ethylene, and are therefore self-ripening and self-destructing. Attempts to control ripening have been based on removing or inhibiting ethylene, but these are expensive and require sophisticated technology.

By contrast, genetic engineering can modify the genes responsible for ethylene production and other features of the ripening process and thereby create a cultivar that will by itself have a longer shelf life and better flavour retention, without the need for advanced storage equipment. This approach has worked with tomatoes, and genetically modified varieties are already on sale. This project is applying similar genetic engineering techniques to the creation of modified papaya and will also start on tissue culture preparation of mango — a necessary precursor step to enable genetic modification to take place later. The main aim of this work is to produce genetically modified strains of papaya that keep their quality for longer after harvesting.

Project progress

Year 8 (01/07/2004 to 30/06/2005)

This work seeks to produce trees which exhibit a delayed response to the fruit ripening process. Papaya is the model chosen for this procedure, since it is both a commercially valuable crop and has a relatively rapid life cycle for a fruiting tree.

Australia

Carica papaya cv 'Sunrise Solo' tissue culture: No more plants remain in tissue culture. All plants have been transferred to soil and after acclimation in glasshouse have been taken to the field trial site.

Carica papaya cv 'Sunrise Solo' Field trials: Eighty-six papaya trees are in the field, comprising 16 transgenic lines and 23 non-transgenic control lines. All trees have been characterised as well as the fruits. Three different lines have shown promising results of delaying ripening by up to 50 per cent

compared with fruits from wild type and non-transformed trees. Black light insect traps are constantly in operation to determine the effectiveness of the netting.

Over 60 independent transgenic lines carrying 'RNA interference' constructs, targeting the same genes as the first set are now in the field trials site. Preliminary analysis of the fruits from over 40 lines have identified some trees producing fruits in which ripening has been considerably delayed (up to three times the length of control fruits). Molecular analysis of the trees (PCR) as well as the fruits are taking place at this time.

Philippines

Papaya transformation subprogram and greenhouse evaluation of transgenic papaya plants: To avoid transfer of Papaya Ringspot Virus (PRSV) infection to the extension of the BL2 greenhouse, new seedlings were hardened inside a net in the extension and observed. No infection was observed among the seedlings in the extension. Among the trees planted in the extension are five siblings of the second generation of line 213, and first generation trees of four different lines of transgenic papayas. The papayas were noted to grow more vigorously in the extension than in the older BL2 greenhouse. Several papaya plants were left in the old greenhouse to allow them to fruit. Such trees were regularly sprayed with insecticide to destroy any vector of PRSV. These trees will be destroyed after all their fruits and seeds have been collected. The team is preparing for the bombardment of somatic embryos of papaya with a gene construct which contains parts of the genes of ACC synthase and the PRSV coat protein. This is aimed at introducing traits for delayed ripening and PRSV-resistance.

Mango tissue culture subprogram: Efforts on mango have been focused on tissue culture since the problem on the regeneration of somatic embryos to complete plantlets has not been solved. The tissue culture sub-project group is working on the tissue culture of mango. The molecular sub-project group has isolated and cloned the ripening-related gene of mango.

Malaysia

Cloning of full length ACC synthase cDNA from 'Eksotika' papaya fruit: Cloning of a full length cDNA for PACCS2 from 'Eksotika' was achieved by PCR followed by Rapid Amplification of cDNA Ends.

Glasshouse evaluation of transgenic 'Eksotika' papaya: Five 'Eksotika 1' lines have been produced bearing genetic constructs with either *capacs2* antisense, *capacs2* RNAi, or *capacs1* RNAi.

Project PHT/1997/094: Management of postharvest diseases of sub-tropical and tropical fruit using their natural resistance mechanisms

Overseas Collaborating Countries	Philippines, Sri Lanka
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Queensland Horticulture Institute, Australia
Project Leader	Dr Lindy Coates Phone: 07 38969468 Fax: 07 38969533 Email: lindy.coates@dpi.qld.gov.au
Collaborating Institutions	Department of Agriculture, Sri Lanka University of Peradeniya, Sri Lanka Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, Philippines University of the Philippines at Los Banos, Philippines
Project Budget	\$727,000
Project Duration	01/07/2002 to 31/12/2006 (Project extended from 01/07/2004 to 31/12/2006)
ACIAR Research Program Manager	Dr Greg Johnson

Project background and objectives

Sri Lanka, the Philippines and Australia are significant producers of tropical fruit with good prospects for market development. However with current control measures, field and postharvest disease losses can hamper productivity and hamper market access. The shelf-life of most tropical and subtropical fruit crops is limited by their high susceptibility to postharvest diseases caused by *Colletotrichum* spp. (anthracnose), *Lasiodiplodia theobromae* and anamorphs of *Botryosphaeria* spp. (stem-end rot), with losses of 20 per cent common. In mango, anthracnose also blights flowers and can cause complete crop loss before harvest, particularly if rain occurs at flowering. Field application of fungicides (e.g. copper compounds, mancozeb), and postharvest treatment with hot water and fungicides, currently form the basis for control of these pathogens, however due to the inadequacy of current options for field and postharvest disease control, alternative strategies need to be developed.

In developing disease management strategies for fruit, little attention has been given to the fact that plants have evolved powerful defence mechanisms to limit and prevent disease on developing fruit. These include biochemical (eg. pathogenesis-related proteins, phytoalexins) and physical (eg. lignification) barriers to pathogen invasion, and may be constitutive (ie. preformed) or inducible in nature. The chemical defences, involving preformed or induced chemicals, cause infections to remain localized and quiescent (with colonization restricted). As climacteric fruit ripen, the defence mechanisms begin to break down (antifungal compound levels drop) and disease begins to develop. Some cultivars have naturally higher levels of the constitutive antifungals (e.g. cv Hass avocado) and so disease development in ripening fruit is delayed, allowing more fruit to be marketed and consumed before disease develops. Furthermore, constitutive mechanisms may be up-regulated (induced) by a range of elicitors, to enhance host defences (and delay disease development). This project is exploiting those mechanisms to define new options for disease control. The project is improving control options for field and postharvest diseases of tropical fruit to reduce reliance on current controls, which do not reliably ensure longer storage of fruit during retail marketing and export.

Project progress

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

Host defence mechanisms in mango and avocado fruit: Mango peel and sap extracts have been analysed for quantification of constitutive antifungal compounds 5-n-heptadecenylresorcinol (C17:1) and 5-n-pentadecylresorcinol (C15:0). The analyses confirm that the heptadecenyl resorcinol is most abundant in mango. Pentadecyl resorcinol is also present in lower amounts. The abundance of the compounds varies among cultivars. These findings are in line with comparative reaction to inoculation with *Colletotrichum gloeosporioides*, the anthracnose pathogen. Similar varietal responses to

anthracnose have been reported in Sri Lankan cultivars, and analyses of their antifungal compounds are underway in Sri Lanka. A second season's field trial has demonstrated that maintaining two to three centimetre stalks at harvest could reduce the severity of postharvest anthracnose and stem-end rot diseases. Further analyses demonstrated a strong relationship between resorcinol compounds, skin nitrogen and amount of nitrogen fertiliser applied to mango trees. As skin N increases, resorcinol levels decrease. These studies imply a major role for constitutive resorcinol compounds in the defence response of mango to these pathogens.

In field studies, pre-harvest treatment with the plant defence activator acibenzolar-S-methyl (ASM, Bion) again significantly enhanced resistance to postharvest anthracnose in mango. Another product, soluble potassium silicate, which may function similarly to ASM, was also trialled, and shown to enhance resistance to anthracnose. Treatments were effective when applied three times through the fruiting period as a fruit dip, or soil drench. Field spray treatments with salicylic acid also reduced severity of anthracnose. There was evidence from laboratory tests that postharvest exposure of mango fruit to ultra violet-C radiation, or treatment with ASM or salicylic acid (SA) could also decrease the severity of anthracnose. The apparent induction of resistance by these field and lab treatments was often accompanied by increases in activities of pathogenesis-related proteins, chitinase and B-1-3-glucanase. Continued research on fertiliser effects in mango and banana showed that high nitrogen levels increased severity of anthracnose, but high potassium levels actually reduced anthracnose severity.

Freckle-induced resistance in banana fruit: In Sri Lanka, polyacrylamide gel electrophoresis of extracts from banana infected with the freckle pathogen, *Phyllosticta musarum*, showed presence of at least six proteins or peptides that were absent or less intense in non-infected banana. Chitinase activity and total phenolic compounds were also enhanced in infected banana. A polysaccharide fraction from pycnidia of the freckle fungus has been partially purified. It is particularly effective at eliciting phytoalexin accumulation and phenolic-associated browning when applied to banana petiole segments. It is being further purified by gel filtration chromatography.

This project was extended to the Philippines during this reporting period, with co-funding from AusAID for the Philippines-Australia component. The first annual report for the Philippines component is not due until 31 December 2005. In August 2004, the Philippines project leader and partners from the University of the Philippines at Los Baños and Mindanao Provincial agencies visited Australia. The team met colleagues at DPI&F Indooroopilly and Nambour, and were briefed on the activities of the Sri Lankan component of the project.

Project PHT/2003/071: Integrated pest management and supply chain improvement for mangoes in the Philippines and Australia

Overseas Collaborating Countries	Philippines
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Queensland Horticulture Institute, Australia
Project Leader	Mr Rod Jordan Phone: 07 38969450 Fax: 0738969677 Email: rod.jordan@dpi.qld.gov.au
Collaborating Institutions	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, Philippines Department of Agriculture, Fisheries and Forestry, Australia Department of Agriculture, Philippines National Mango Research and Development Centre, Philippines
Project Budget	\$943,617
Project Duration	01/01/2005 to 30/06/2008
ACIAR Research Program Manager	Dr Greg Johnson

Project background and objectives

Mangoes are a popular fruit in many tropical countries in Asia and in Australia. The Philippines has a mature mango industry based on the Carabao cultivar. A large proportion of this industry is based in Luzon on the southern island of Mindanao and Guimaras in the Visayas. Smallholder production, defined as farms less than three hectares, accounts for 48 per cent of total Philippines production. The Philippines produces around 880,000 tons each year. Of this between 36,000 to 40,000 is exported, making the country the world's second largest exporter after Mexico, representing around 5.9 per cent of global trade. There is significant scope to increase this production and trade further, as pest and disease losses, production variability, fruit perishability and supply chain management all limit potential. The Australian industry does not have the breadth of problems but does have some pest control and quarantine issues.

Insect pests are a significant problem in both countries. A field infestation has the potential to cause losses of between 10 to 40 per cent. These can also limit market access domestically and internationally. Pesticides are frequently used, often to excess, prompting concerns relating to pesticide residues. New pests emerging in the Philippines also require that Integrated Pest Management strategies address new threats and excessive pesticide use. In addition improvements in the supply chain are likely to help reduce losses and foster better pre and postharvest practices at all levels. The sustainability of mango industries in the Philippines and Australia will be enhanced through a systems approach to improving pest management and the consistency of supply and quality of mangoes for targeted markets.

Project progress

Year 1 (01/01/2005-31/12/2005)

The first progress report is due in early 2006.

Project PHT/2005/017: Information, knowledge, and training gaps in the postharvest sector of the Philippines grain industry

Overseas Collaborating Countries	Philippines
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Australia
Project Leader	Dr Greg Daghish Phone: 07 3877 9415 Fax: 07 3896 9446 Email: Greg.Daghish@dpi.qld.gov.au
Collaborating Institutions	Not applicable
Project Budget	\$100,000
Project Duration	22/06/2005 to 31/12/2005
ACIAR Research Program Manager	Dr Greg Johnson

Project background and objectives

In March 2005, ACIAR began working in partnership with the Bureau of Postharvest Research and Extension (BPRES) in the Philippines, to identify options for follow-up on earlier projects which involved BPRES formerly (NAPHIRE), the Queensland Department of Primary Industries and Fisheries (DPI&F) and other Australian agency partners.

This consultancy is involving staff from DPI&F working in collaboration with BPRES and other stakeholders, to identify and address information, knowledge and training gaps and initiate study of postharvest grain systems focussing on smallholders.

Project progress

Year 1 (22/06/2005 to 31/12/2005)

The first progress report is due in early 2006.

Project SMCN/2000/114: Evaluating biofumigation for soil-borne disease management in tropical vegetable production

Overseas Collaborating Countries	Philippines
Commissioned Organisation	CSIRO Plant Industry, Australia
Project Leader	Dr John Kirkegaard Phone: 02 6246 5080 Fax: 02 6246 5399 Email: John.Kirkegaard@csiro.au
Collaborating Institutions	Benguet State University, Philippines University of the Philippines at Los Banos, Philippines Queensland Department of Primary Industries and Fisheries, Australia
Project Budget	\$399,039
Project Duration	01/01/2001 to 30/06/2006 (Project extended from 01/01/2005 to 30/06/2006)
ACIAR Research Program Manager	Dr Christian Roth

Project background and objectives

This project has arisen from recent research to investigate the potential of biofumigation by brassicaceous crops for pest and disease suppression in various farming systems. In Australia observations of superior wheat growth following *Brassica* rotation crops, led to the identification of this suppression of soil-borne pathogens by root-derived biocides released in soil. From broad-acre agriculture, interest in the concept spread into horticultural industries, driven mainly by the search for alternatives to methyl bromide (MB) and other synthetic fumigants, reports of enhanced biodegradation of the major chemical alternatives to MB, and a general desire to move towards more environmentally benign production systems.

The most serious soil-borne diseases of solanaceous vegetable crops such as eggplant, tomato and potatoes in tropical environments are bacterial wilt (BW) caused by *Ralstonia solanacearum* and to a lesser extent root knot nematodes (*Meloidogyne* spp.). Biofumigation using Indian mustard (*Brassica juncea*) green manure is effective in reducing the level of BW in the soil, and lessening the severity of the disease in a following tobacco crop. A commercially available Indian mustard biofumigant green manure was shown to significantly reduce bacterial wilt in a following potato crop, resulting in spectacular yield increases (from 0.3 to 22 t/ha). The fact that such results were obtained with no purposeful selection of brassicas for high biofumigant properties indicates there may be significant scope to improve the level of suppression achieved. This project is studying the 'biofumigation' properties of brassicas as rotation, companion or green manure crops, and the use of these properties in managing two important pathogens of tropical vegetable production systems in Australia and the Philippines - bacterial wilt (*Ralstonia solanacearum*) and root-knot nematodes (*Meloidogyne* spp.).

Project progress

Year 4 (01/01/2004-31/12/2004)

All of the planned objectives for this extension period were achieved with few exceptions. The major activities were:

- to publish key results arising from the project to date,
- conduct an on-farm demonstration experiment in North Queensland to evaluate biofumigation on a commercial farm and showcase the "best-bet" biofumigation strategy to key Industry stakeholders,
- develop the forward plan for the Philippine work to develop, test, and extend practical biofumigation strategies in The Philippines, and
- prepare for the Australian experiments in 2005 aimed at separating the isothiocyanates impacts of biofumigants from the general suppression arising from organic matter.

Objectives two through four were completed according to plans, and one of the planned publications in objective one has been submitted to an international scientific journal.

The most notable outcome was the poor control of bacterial wilt in cherry tomatoes observed in the “best-bet” demonstration experiment on Endeavour Farm near Mareeba (Queensland). This was in contrast to the excellent results reported using the same strategy on tomatoes at Southedge Research Station in 2003. Although there were some possible issues due to the size of the tomato plants at transplanting (too old) which may have made them particularly sensitive to bacterial wilt during a very hot period in early October, a more plausible explanation was the higher clay and organic matter content of the soil at Endeavour Farm compared with the very sandy soil at the Southedge Research Station.

Recent published data highlights the impact of clay and organic matter on increasing the isothiocyanates sorption in soils so that much higher levels are required for pest control. This important practical outcome has been followed up in subsequent experiments on the two soils (Southedge and Endeavour) with the hypothesis appearing to be valid. It is an important further refinement to the practical “best-bet” advice on biofumigation as it indicates that biofumigation (i.e. the isothiocyanates impact) of brassicas may be most effective on lighter textured soils, and may not be successful on heavier soils. The result has delayed one of the planned publications of the laboratory screening methodology for bacterial wilt, as we considered it prudent to check it on a greater range of soil types prior to publication.

Project ASEM/2005/058: Community Agricultural Technologies: better practice workshop series

Overseas Collaborating Countries	Philippines
Commissioned Organisation	International Institute for Rural Reconstruction, Philippines
Project Leader	Dr Scott Killough
Collaborating Institutions	Not applicable
Project Budget	\$71,800
Project Duration	27/08/2005 to 16/12/2005
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

The adoption of agricultural innovations depends on many factors. In the Philippines adoption has often been slow; a series of factors all contributing. Amongst these are a separation of government research and extension agencies, travel and funding constraints for both parties and difficulties with linking farmers and knowledge providers, including NGOs. The Community Agricultural Technologies program is an initiative aimed at these particular challenges to adoption.

A series of workshops will introduce concepts successfully proven in Thailand, Vietnam and Laos to support extension workers in facilitating adoption of innovations by farmers. A suite of follow-on mini-projects will then be used to facilitate action learning processes, introduced to extension staff via the workshops. These will test best practice adoption, and link Australian and Philippine researchers involved in ACIAR projects to NGOs and extension groups working with farming communities.

Project progress

Year 1 (27/08/2005 to 16/12/2005)

The first progress report is due in early 2006.

Project CIM/2002/106: Fertilisation-independent formation of embryo, endosperm and pericarp for apomictic hybrid rice

Overseas Collaborating Countries	Philippines
Commissioned Organisation	International Rice Research Institute, Philippines
Project Leader	Dr John Bennett Phone: 63 2 8450563 Fax: 63 2 8450606 Email: J.BENNETT@cgiar.org
Collaborating Institutions	CSIRO Plant Industry, Australia International Rice Research Institute, Philippines
Project Budget	\$1,500,000
Project Duration	01/07/2003 to 30/06/2008
ACIAR Research Program Manager	Mr John Cullen

Project background and objectives

Stagnating productivity of irrigated rice (*Oryza sativa*) over the past decade has seen the rate of increase in production fall below the rate of population increases. This creates concerns for medium to long-term food security. Throughout Asia rice is the staple crop food, with more than 90 per cent of all rice grown in the region and 50 per cent of dietary calories coming from rice consumption. Hybrid rice, incorporating two or more differing rice lines with traits from both parents, has been shown to provide yield boosts. In China the introduction of hybrid rice accounted for a one-off yield increase of around 30 per cent in production per hectare. Other Asian countries are hoping to use hybrids to reproduce this boost. Most hybrid varieties are intrasubspecific (for instance two lines from the same type – indica/indica). It is expected that these hybrids will be superseded by intersubspecific hybrids that offer greater advantages through combining two lines of different types with a combined traits of both parents.

Making high-yielding hybrid varieties available to the poor may be helped by one-line or apomictic production. This is potentially cheaper and more flexible than multi-line hybrids while still offering the same advantages. One line hybrids reproduce asexually through apomixis (fertilisation of the egg by non-sexual means). In rice this process is possible through synthetic activation of apomixis. Achieving this in single line hybrids would be cheaper and more likely to ensure equal yields than in multi-line hybrids. Through this project research will address key issues in developing apomictic rice, focusing on the role of fertilisation independent genes in other plants for their application to hybrid rice.

Project progress

Year 2 (01/07/2004-30/06/2005)

Fertilization-independent (FI) formation of rice endosperm and pericarp: In rice (*Oryza sativa*) a specific function (*OsAsp1*) encodes a possible aspartate proteinase (an amino-acid based enzyme that degrades proteins) that is unusual among plant aspartate proteinases. When an promoter/reporter gene fusion (*OsAsp1:gus*) for this function was transferred into rice using *Agrobacterium*, a form of parthenogenesis (reproduction by an unfertilised egg developing) was observed. This ability to by-pass the checkpoint that normally prevents ovary expansion in the absence of fertilization may be very important in relation to achieving full fertilisation independent endosperm expansion.

It has been shown that recombinant *OsAsp1* expressed in *E. coli* does encode an active proteinase, which is capable of not only hydrolysing artificial substrates (converting material on the surface or within a cell in which organisms grow by converting the chemical composition) but also removing its own N-terminal pro-sequence.

Refined FI endosperm formation based on ribonucleic acid-1 (RNA-I) of rice fertilisation independent seed genes: Mutations in *Arabidopsis* fertilisation independent seed (FIS) genes produce the fertilisation independent seed. A similar ribonucleic acid construct (an RNA-I) against a rice gene

(*FIS3* from rice, or FIR rice gene) similar to the Arabidopsis *FIS3* gene was introduced. Transgenic lines harbouring this introduced *FIR-RNA-I* mutation contained shrivelled grains, similar to fertilised *fis3* mutant lines. Autonomous grain-like structures can be seen in the transgenic lines amongst empty grains at a 1:1 ratio. More work is needed in the FIR-RNA-I line to actually demonstrate autonomous growth of endosperm in these lines.

Also observed was a fertilisation independent pericarp (the outer layer around the ovary wall of the seed) structure in a tagged line isolated by CSIRO. Cloning DNA adjacent to the insertion site (of the gene) identifies the gene as a small dehydrogenase/hydrolase (a genetic construct to catalyse chemical changes) in Chromosome 9. In Arabidopsis it was demonstrated that an antisense construct (nucleic acid that helps DNA act) against the DNA methyltransferase (MET) gene causes fertilisation independent empty seed formation. This knowledge has been used to make an RNA-I against the rice methyltransferase 1 gene with the construct about to be introduced into rice. Recent sequencing data from rice also indicate that there are two *FIS3* like genes in rice.

Fl embryogenesis in rice nucellus — Isolated rice orthologues of Arabidopsis genes: Putative rice orthologues (genes in different species from a common ancestor) known to stimulate embryogenesis (growing plant tissues in an artificial environment) have been identified at the International Rice Research Institute. Their functional identities are now being confirmed, with two homologues for these functions in Arabidopsis having been identified.

A system to control genes of nucellus (the central cellular mass of the ovule) from the megaspore mother cell (which triggers division of cells during reproduction) is being investigated. Two rice genes have been identified that are putative ligands (molecules) of a rice orthologue of maize (*Msp1*) and that may control the behaviour of surrounding nucellar cells through interaction with *Msp1*. Ribonucleic acid *in situ* hybridisation and RNA-I are being used to confirm and characterise the putative ligands. These genes will be tested for their ability to constitute a system for controlling gene expression in nucellar cells. If successful, the system will be used to drive nucellar embryogenesis at the time of meiosis.

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

Overseas Collaborating Countries	Malaysia, Philippines, Thailand, Vietnam
Commissioned Organisation	International Plant Genetic Resources Institute, Malaysia
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Collaborating Institutions	Griffith University, Australia Department of Agriculture, Thailand Institute of Agricultural Genetics, Vietnam University of the Philippines at Los Banos, Philippines Universiti Kebangsaan Malaysia, Malaysia
Project Budget	\$746,479
Project Duration	01/01/2003 to 31/12/2005
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

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

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

Project progress

Year 2 (01/01/2004-31/12/2004)

Cryopreservation studies for the identified crops (mango, papaya, Australian native fruits, *Nephelium*, citrus, persimmon, litchi and longan) were performed using materials propagated in Year 1. Preliminary cryopreservation studies were already reported for some crops like papaya, citrus and Australian native fruits in Year 1.

Somatic embryogenesis have been developed for *Citrofortunella microcarpa*, *Citrus reticulata*, *C. aurantifolia*, *C. sinensis* and *C. suhuiensis* and multiple shoot formation was obtained for *Citrofortunella microcarpa*, *C. reticulata* and *C. hystrix*. Protocols have been refined for micropropagation and shoot and plantlet regeneration via organogenesis of some Australian native fruits. Micropropagation and plantlet regeneration from *in vitro* nodal cuttings of three Australian Citrus species (*Citrus inodora*, *C. garrawayi* and *C. australasica*) has been achieved. Adventitious shoots were obtained for both litchi and longan. Persimmon callus was formed and used for cryo-assays. Adventitious buds were formed from embryonic shoots of persimmon. Genetic fidelity testing for tissue cultured and non-tissue cultured plants of *Citrofortunella macrocarpa*, *C. reticulata*, *C. aurantifolia* and *C. grandis* were evaluated using 11 enzyme systems and no differences was found in banding patterns between tissue cultured and non-tissue cultured plants.

In developing cryopreservation techniques, seed desiccation sensitivity was tested for *Citrus reticulata*, *C. sinensis*, *C. medica*, *Citrofortunella macrocarpa*, *C. aurantifolia*, *C. hystrix* and *C. nobilis* as well as for longan seeds and excised embryonic axes of persimmon. Experiments with desiccation of *C. australasica* seeds showed tolerance to ultra low temperatures and had normal morphology post-cryopreservation. In another study, the optimum duration was found for *C. reticulata* and *C. nobilis*.

Encapsulation dehydration (ED) and vitrification methods were tried for several Citrus varieties with successful recovery. The results suggested that ED may not be a suitable technique for cryopreservation of somatic embryos. Cryopreservation of embryonic axes of *C. grandis* using ED method was performed and the results provided initial data on the potential of cryopreservation of *C. grandis* embryonic axes. Promising results were obtained for *C. hystrix* as well using the ED method. Cryopreservation of mature *Citrofortunella macrocarpa* seeds using desiccation proved to be a very simple method of preserving its germplasm. Embryogenic callus of Som-Keaw-Wan (*C. reticulata*) Som-Shokun (*C. reticulata*), Som Chengh (*C. sinensis*) were cryopreserved using new ED. Results showed that pretreatment affected the percentage of moisture content after desiccation in various time. The results of this experiment showed that new ED with pretreatment solution was better than conventional ED. For *C. reticulata* and *C. nobilis*, the pregrowth duration had significant effect on survival of its cryopreserved embryonic axes.

Papaya shoot tip cryopreservation protocol was improved to be applicable to a wide range of genotypes by optimization factors influencing vitrification. Eight different genotypes were selected to compare the old and refined protocol and all were successfully cryopreserved with recovery rates varying from 36 per cent to 60 per cent.

Preliminary tests for cryopreservation of *Nephelium* were carried out. Progress on developing a suitable cryopreservation method for this difficult species has been made and the results obtained so far has provided guidance on the approach for further work.

For Australian native species, shoot tips of *Citrus australasica* were successfully recovered after encapsulation and desiccation and Murcott tissue was cryopreserved using a slow freezing approach.

Fine suspension cultures of mangoes were cryopreserved and viable embryos were recovered post-cryopreservation. Recent experiments have successfully replaced the toxic DMSO in the vitrification stage.

Slow growth protocol was developed for mandarin by testing varying concentration of mannitol and sorbitol. Using MS medium without growth regulator and supplemented with sucrose as carbon source slowed down growth of mandarin shoots. Slow growth protocols papaya plants *in vitro* were refined and cryopreservation of shoot tips and seeds achieved by using modified medium for the papaya micro-cutting system. Plants can be held for 8 to 12 months before transfer. The use of fructose in lieu of sucrose slows the growth considerably and allows incubation at 25°C. This is essential, as tropical species cannot be incubated at low temperatures due to tissue damage. Considerable progress has been made with experiments on papaya seed desiccation, germination and storage at different temperatures. It was found that desiccation below 15 per cent severely reduces germination percentage and that seed at any moisture content can be germinated with gibberellic acid or heat shock treatments. Seed that were stored for 1 month had germination percentages as high as 80 per cent.

The project's Second Annual Meeting was organized as planned in Hanoi, Vietnam from 8-11 December, 2004 and country coordinators had the opportunity to review and discuss their work together. Techniques and information were shared among the country coordinators.

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

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

Project background and objectives

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

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

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

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

Project progress

Year 1 (01/01/2004 – 31/12/2004)

This report focuses on work to determine the occurrence and extent of work-related migration and off-farm work in major rice-based or mixed farming systems in Vietnam, Thailand, the Philippines, and Australia. The first-year activities included reconnaissance, a rapid rural appraisal (RRA), and focus-group discussions (FGDs) in the Philippines, Thailand, Vietnam, and Australia. The focus of the research in Thailand, Vietnam, and the Philippines is on the out-migration of individuals of farming households, while that in Australia is on the incidence of off-farm work. Research villages in Thailand, the Philippines, and Vietnam were selected based on criteria such as representing typical rice-

growing areas under different water regimes (rainfed and irrigated) and access to labour markets (low and high). A structured guide was developed for collecting village-level information, incidence of out-migration, patterns of migration, and characteristics of migrants. FGDs were conducted with key informants to gain perceptions on labour out-migration. Migrants are defined as those individuals who have changed residence for more than 3 months and send remittances. The incidence of out-migration was calculated among farming households, males, and females.

The results of the RRA showed that the proportion of households with migrants is higher in Thailand than in the Philippines and Vietnam. A higher proportion of males than females migrate in Thailand and Vietnam and vice versa in the Philippines. The incidence of out-migration is generally higher in rainfed ecosystems than in irrigated ecosystems. Rural to urban migration is prevalent in Thailand and Vietnam because of more employment opportunities in nearby districts and provinces brought about by rapid industrialisation and better communication and transportation facilities. In the Philippines, although rural to urban migration occurs, domestic to international migration is more prevalent. In Vietnam, men work as construction workers and masons in the cities and as hired fishermen, in seafishing, and with shrimp or squid catching in other provinces. Women work in waste trading and small trading, as hired labourers in rice farming, sand boating workers, domestic helpers, and factory workers, or in other industrial areas near rural areas. In Thailand, male and female migrants work as construction workers, factory workers, and in the trading/business and service sector. In the Philippines, female migrants mainly work as domestic helpers and entertainers within the Philippines and in the Middle East, Italy, Singapore, and Hong Kong. Others work as factory workers in Taiwan, Japan, and Korea. Male migrants work in the Middle East as construction workers, drivers, operators of heavy equipment, or seamen.

FGDs revealed that low rice productivity in the rainfed areas, the small size of landholdings, the lack of regular and alternative income sources, low profitability in rice farming due to high input costs, the desire of youth to seek adventure in the cities, and as a status symbol for a household to have a migrant abroad are some of the reasons for migration. Other reasons are the availability of non-farm work because of social networks, better wages, and the attraction of better living conditions in urban areas. Wives mentioned that remittances increase their income and enable them to invest in agriculture, repay their debts, and improve their living conditions. However, when husbands are absent on a long-term basis, the women face loneliness, insecurity, and emotional stress when remittances do not come on time for children's education, farm inputs, and other household expenditures. Women take on additional responsibilities of managing the farms.

It is clear that labour out-migration and/or off-farm work are occurring in all countries involved although the rates vary. The impact of family migration on agricultural productivity, farming efficiency, household welfare, and the changing role of women will be analysed in the next phase of the study

Concluded projects

at 30 June 2005

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Project AS2/2001/029: Development of a knowledge system for the selection of forages for farming systems in the tropics

Overseas Collaborating Countries	China, India, Indonesia, Pakistan, Philippines, South Africa, Vietnam
Commissioned Organisation	CSIRO Sustainable Ecosystems, Australia
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Collaborating Institutions	Queensland Department of Primary Industries and Fisheries, Australia International Livestock Research Institute, Ethiopia International Centre for Tropical Agriculture, Colombia University of Queensland, Australia Global Overseas Collaborators, Global
Project Budget	\$837,717
Project Duration	01/07/2002 to 30/06/2005
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

The demand for livestock products is expected to double by 2020. Smallholder farmers in developing countries, through more efficient and productive farming, will be able to benefit from this increase in demand. One way to achieve this is through planting well-adapted forages. However, it is often difficult for people in developing countries to identify and obtain the best possible forage. At present, much of the important information is fragmented, unpublished or published in media of limited circulation. A database is needed to capture the accumulated knowledge in a form that is applicable to all farming systems in the tropics.

The aim of this project is to develop a database that will help smallholder farmers in the tropics to select the best possible forage for their situation. The Selection of Forages for the Tropics (SoFT) database will allow smallholders to improve their productivity and thus benefit from an increasing demand for livestock products.

Project Outcomes

This project accessed the best available information for adaptation and use of 180 tropical forage species and their elite cultivars integrated in a single user-friendly database. The database, which includes a simple-to-use tool to assist in the selection of the best-bet species, is now freely available on the Internet (www.tropicalforages.info) and on CD.

The database has five main features:

- information in fact sheets on the adaptation, uses and management of forage species, cultivars and elite accessions;
- a selection tool built on LUCID that enables easy identification of best-bet species;
- a bibliography of more than 6,000 references and abstracts on forage diversity, management and use which will enable users with poor library facilities to access summaries of some of the key literature;
- global maps of climate adaptation for each species; and
- a collection of photographs and images of species to help in their identification and use.

The database selection tool is an expert system based on the experiences of forage specialists who have worked for many years in tropical and subtropical regions of Africa, lower latitude USA, Central and South America, South and South-east Asia and Australia. Selections were made on the basis of

19 criteria. The project brought teams of experts together in workshops in Africa, Asia, South America, Central America, Europe and Australia over a two year period and had input from other forage specialists during the database development.

The principal outcome summarised information on tropical forage adaptation and use from expert knowledge, available literature and experiential sources made available in a readily accessible and consistent format. With availability on DVD and the Internet, the database allows researchers and advisors to select those forages most suitable for local conditions. Although the database was initially designed for use in developing countries, its content includes species adapted to farming systems in developed countries and is equally applicable in these regions. The database covers a wide range of forage uses and allows users to select among many different farming systems ranging from permanent to short term pastures, with applications in agroforestry, inter-row cropping, cut-and-carry, hedgerows, green manures and ground covers.

The database has been recognised as a valuable teaching tool for colleges and universities with feedback from many university staff from a wide range of countries attesting that the database and selection tool will have a major role in improving the way tropical forage science is taught.

The database was promoted during regional workshops, through partner organisations including CIAT and ILRI. The project team also conducted database demonstrations at the XX International Grassland Congress, held in Ireland in June 2005. Over 100 tropical forage agronomists trialled the selection tool and fact sheets. FAO became included in the project's partnership and agreement after discussions over the past three years. Involvement with FAO will further promote awareness of this database internationally.

The database resides on the CIAT Internet server and where it is maintained and updated. After a few months a need for information to be added to the fact sheets was identified and requests for additional funding have been made. CIAT is also exploring possibilities for the database to be translated into Spanish to encourage application in Latin America and the Caribbean.

Project ASEM/1997/041: Enhancing the contribution of livestock within smallholder mixed farming systems in the Philippines

Overseas Collaborating Countries	Philippines
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Collaborating Institutions	Leyte State University, Philippines Curtin University of Technology, Australia Queensland Department of Primary Industries and Fisheries, Australia
Project Budget	\$893,746
Project Duration	01/07/2000 to 31/12/2004 (Project extended from 01/01/2003 to 31/12/2004)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Opportunities for improved livestock productivity in Southeast Asia have been identified at several international meetings. Poor feed resources are now seen as one of the most important factors constraining productivity for all livestock in the smallholder sector. In Leyte in the Philippines this affects village pigs and poultry. This project, known in the Philippines as the Leyte Livestock Improvement Program (LLIP), focused on increasing the production of higher protein feeds and conserving feedstuffs that are available irregularly or seasonally, so as to make the production system more sustainable.

The project also addressed the poor record in adoption of agricultural technology and concerns about the effectiveness of the traditional 'transfer of technology' approach. The research was participative from the start, in the hope that this would lead to greater adoption. Many agricultural communities in Australia also face adoption problems, and the project also focused on the Australian pork industry. The project aimed to increase the capacity of participating producers to improve the management, profitability and long-term sustainability of their livestock systems. Using a continuous improvement approach their creativity, decisions, processes, practices and performance were focal points, along with improving the contribution of livestock to the social and economic wellbeing of smallholder families in western Leyte.

Project outcomes

The program developed and promoted the Leyte Improvement and Innovation Network (LIIN), designed to help members adopt continuous improvement and innovation (CI&I) methods. Building a LIIN based on mutual responsibility-taking and support was novel in a region that had previously experienced many aid projects based on 'dole-outs'. The concept needed time to be experienced, developed and assessed. In October 2003, LIIN farmer members scored an average of 8.9/10 for their understanding of LIIN; 7.9/10 for the value of working together in a network; and 8.4/10 for their motivation for continuing the network.

Working in teams using the CI&I process and tools enabled farmers and partners to establish effective and cooperative approaches with technical specialists and other partners, to achieve their target outcomes. All Philippine and some Australian LLIP staff achieved accreditation in the University of Queensland's 'Continuous Improvement and Innovation' course.

Fifty-five LIIN pig farmers focused on improving profit by five per cent per year. Forty-five of these worked with LLIP to increase understanding of smallholder pig production and marketing as a system,

build capacity to assess alternate management practices in relation to profit, and implement and monitor their chosen strategies to improve pig profit.

The Hindang Swine Raisers' Association team of farmers established a local 'Agri-Vet' store, which raised capital by pooling farmers' savings, then used the capital to buy feed, giving individual members quick and convenient access to better quality inputs at lower costs.

The chicken profit improvement process encouraged farmers to identify and rank opportunities to achieve greatest impact on profit. Twenty-four LIIN chicken farmers originally chose to focus on improving profit by five per cent per year, and of these 16 retained profit from raising chickens as a focus for four years. All 24 continued to keep chickens, though some recorded a financial loss from doing so.

Smallhold farmers' raising pigs in densely populated environments have compelling reasons to improve the management of their pig waste. At the start of LLIP, 59 pig farmers chose to focus on managing pig waste. Twenty-seven of them developed and implemented at least one plan of action to improve their waste management: 12 installed concrete biodigesters, four plastic biodigesters and 11 reduced pig waste at the pens by collecting manure to dry as fertiliser before washing the pig pen.

Environmental benefits included cleaner waterways and fewer problems with mosquitoes and flies. Social benefits include improved relationships with neighbours, often linked to reduced on-farm smell; greater cleanliness of farmers' immediate surroundings; and greater confidence in raising pigs. Efficiency benefits include using the pig waste as an input to biodigesters to produce gas for cooking, and as a fertiliser for crops. The success of this subproject prompted farmers and local government units around the Eastern Visayas region to request LLIP extend its pig environment improvement work.

Twelve farmers from the original six LIIN farmer teams participated in the development of a pig and chicken production and profit information system. This entailed six months recording and analysis of economic and biological key performance indicators for improving profit. Farmers used this information both to benchmark their performance against group averages, and to improve their decision-making on production and marketing matters. Participating farmers indicated that the production and profit information system helped them to enhance their decision-making.

Project ASEM/2000/088: Redevelopment of a timber industry following extensive land clearing

Overseas Collaborating Countries	Philippines
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Collaborating Institutions	Leyte State University, Philippines Southern Cross University, Australia
Project Budget	\$398,911
Project Duration	01/01/2001 to 31/12/2004 (Project extended from 01/01/2004 to 31/12/2004)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Leyte Province in the Philippines and the Atherton Tablelands in North Queensland have historically been home to major timber industries. In both cases the industry was once based on extensive logging of native forests, but more recently the remaining resources have been protected and a shortage of timber has ensued. Both regions experience relatively high rainfall and have farmland available for reforestation. The technology for tree establishment is established in both, and a wide variety of tree species (particularly hardwoods) will grow rapidly on moderate to high quality land in the two areas. The governments in both regions attach a high priority to reforestation and to private forestry, including agroforestry and community forestry. But, despite all this, the rate of reforestation has been disappointingly slow. It was clear that, rather than simply matching species to sites and other basic biophysical work, a wider analysis of the problem was necessary.

In 1999, socioeconomic research on the degree of adoption of Australian tree species in the Philippines showed that, although there were large areas of cleared land in which forestry was probably the best form of land use, the uptake of forestry using both traditional and Australian species was low. This project was therefore commissioned to study landholder attitudes to farm and community forestry, as well as looking at land suitability and availability, sources of potential finance, the likely yields from various species and systems, and the extent of markets. Using data from these social and economic analyses, the project assessed the most suitable forestry systems for the development of both timber and non-wood forest products. The project aimed to examine the requirements and opportunities for a more rapid development of farm and community forestry in Leyte province in the Philippines and in Australia's Atherton Tablelands.

Project outcomes

Results of the research indicated that Leyte tree farmers could receive much greater financial returns from their tree farms if they had better market access and knowledge of prices, produced greater volumes of timber per unit of cost, and produced better timber of appropriate species, log size and quality as desired by the market.

There are many institutional impediments restricting the ability of farmers to register trees. Such impediments act as a barrier to gaining access to markets and restrict timber sales to non-competitive local markets. In addition, many smallholders lack information about how and where to market their trees, and have no knowledge of their current market value. Smallholders also do not manage their tree farms to optimise the production of desired products.

Key impediments to forestry development, in particular a number of policy aspects (including problems with land tenure and property rights), were identified. Some landholders were unwilling to commit resources to forestry because they had no land titling and hence regarded their land tenure as

insecure. Similarly, banks appear unwilling to lend to smallholders for investment in forestry, being influenced by lack of collateral associated with insecure land tenure. Therefore help through 'how to' guides for landholders impeded by a lack of education, and assistance with the costs of obtaining land title, would mean many more could obtain secure tenure.

In terms of property rights, there appeared to be little understanding by local governments of the Department of Environment and Natural Resources (DENR) approval procedures for timber harvesting and transport, highlighting the need for improved communication including development of manuals of approval procedures. As well, some DENR policies appear to restrict property rights, and scope exists for designing alternative policies that achieve environmental objectives without placing restrictions on tree planting.

Researchers identified major problems with nursery propagation practices producing poor quality planting stock, which when planted had low survival rates or poor growth. In addition, decisions by nurseries on what to grow relied on species availability rather than what was best suited to local site conditions. New nursery practices were developed, then tested in a community nursery situation. Seedlings raised using different techniques were tested in field trials, which later became demonstration tree farms. The economic analysis of seedling production technologies used in the trials will provide guidance on cost-effective nursery practices.

Recognising the social context of forestry development is critical to the development of successful support measures. Researchers now understand how People's Organisations can become more effective vehicles for implementing community based forest management. They have also identified four landholder 'typologies' or groups, each with distinct characteristics and different attitudes to forestry, and each likely to respond in different ways to initiatives to promote forestry development. Carbon sequestration models have been developed for some species used in smallholder forestry, and researchers have identified the payment methods preferred by smallholders for carbon sequestration by their forests.

The Australian component of the project investigated forest industry development in the wet tropics of north Queensland. Twelve preferred industry development options were identified from interviews with key industry stakeholders and these were assessed by expert panels. Timber markets were identified as a major issue, and participants at a workshop held later concluded that problems with the timber supply chain were the crucial limiting factors to industry development.

Project ASEM/2000/101: Improving the efficiency of the agribusiness supply chain and quality management for small agricultural producers in Mindanao

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Collaborating Institutions	University of the Philippines, Mindanao, School of Management, Philippines
Project Budget	\$342,614
Project Duration	01/01/2001 to 31/12/2004 (Project extended from 01/07/2003 to 31/12/2004)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

The establishment of cooperative marketing groups is one mechanism by which small farmers can improve the marketing of their produce and potentially add value to it, and can also reduce their dependence on rural traders. This project targeted a group of around 3000 farmers in Mindanao working farms located at mid-elevation on mountain slopes. They supply tomatoes and other temperate vegetables to the Luzon and Visayas markets during the typhoon season and to the Mindanao market all year round. Farmers' incomes were low, partly due to poor marketing practices and poor access to markets and information. They were also vulnerable to the market power of rural traders, retailers and processors.

In Mindanao and other areas of the Philippines many cooperatives have failed, due to problems such as poor infrastructure, lack of market information, poor management and inadequate quality control. However, the Philippine government, recognising the social benefits arising from establishment of cooperatives, has given a high priority to their development.

This project was established to find ways to improve the success rate of cooperatives in the Philippines. It aimed to demonstrate that the marketing system used by a group of farm families in Mindanao might be improved through the establishment of well run producer cooperatives.

Project outcomes

The impacts of the project can be seen at the farm-household level (higher income, changes in marketing and agronomic practices), the institutional level (improvements in farmer groups/cooperatives and vegetable industry councils) and the community level (increased awareness of vegetables). A key component of the project has been the encouragement and support it has provided to farmer groups and cooperatives. The impact of this is reflected in the changes occurring in the operations of the Vegetable Industry Council of Southern Mindanao (VICSMIN), KALIDECO Cooperative (which at the beginning of the project was the only remaining cooperative and on the verge of collapse), Maharlika Farmer's Cooperative and Kapatagan Upland Farmers' Development Cooperative.

Farmers who were members of cooperatives or were participants in the workshops now have higher incomes than the farmers without direct involvement in the project. Newly established Maharlika Cooperative is lifting prices to farmers and improving use of pesticides. The councils of Davao City implemented a vegetable awareness campaign, a village vegetable garden program and a vegetable garden contest. VICSMIN has also registered a marketing and trading arm.

Key findings of the agronomic work in Kapatagan were low soil pH, overuse of phosphorus and potassium fertilisers, low soil organic matter and micronutrient deficiencies (e.g. boron). Discussion

with farmers resulted in a dramatic increase in the use of lime to lift the pH. Farmers are now soil testing (with the encouragement of the local council), they make better use of fertilisers, and micronutrient use has increased. Follow-up soil tests conducted in 2004 found a shift towards optimum pH values in the soils in Barangay Kapatagan. Use of boron helped overcome defects in cauliflowers and broccoli.

The project staff assisted the Department of Agriculture to promote the use of biocontrol agents such as the diadegma parasitic wasp as a strategy for environmental sustainability, product differentiation and cost reduction. Kapatagan project data on pesticides and prevalence of natural enemies were useful in support of the strategies.

The University of the Philippines in Mindanao has lifted its capacity to conduct research on complex agribusiness systems. Project members from the University have been asked to participate in a number of Mindanao Policy Review Forums, make recommendations to the President on policy changes and to participate in Mindanao Vegetable Congresses.

This is thought to be the first study in the world to address agricultural development issues using the concept of a supply chain embedded in a dualistic agribusiness systems framework. It is also the first study to develop and implement a methodological framework that integrates diverse methodologies to analyse an agribusiness supply chain and its associated systems. The project provided the first research on supply chain management of agricultural product produced by smallholders in the Philippines. Previous studies were done only by multinational companies for their own corporate use and were not available to policy makers. And it was the first detailed investigation of the impact of vegetable farming and different soil management practices on soil properties in Mindanao.

A number of popular myths were found to have no basis. These were:

- *Pesticide use is a serious health risk to consumers:* residues are at relatively low levels and the pesticides used tend not to be ones that cause serious health problems,
- *Low crop productivity is due to use of low inputs:* on the contrary, farmers tended to put on excess of the wrong inputs, and insufficient of other inputs,
- *Farmers are being taken advantage of by financiers:* this was not a major issue. Farmers prefer to transact with those market intermediaries who pay cash and, with many traders to choose from, they may also act opportunistically, and
- *Market information is lacking:* farmers talk amongst themselves, and while information on the prevailing market prices is widely known they are often unable to respond.

Project FIS/2002/083: An assessment of the patterns of genetic diversity and stock structure in wild populations of the Giant Freshwater Prawn (*Macrobrachium rosenbergii*): a resource for improving culture stocks in Indonesia and the Philippines

Overseas Collaborating Countries	Indonesia, Philippines
Commissioned Organisation	Queensland University of Technology, School of Natural Resource Sciences, Australia
Project Leader	Dr Peter Mather Phone: 07 3864 1737 Fax: 07 3864 1535 Email: p.mather@qut.edu.au
Collaborating Institutions	Research Institute for Freshwater Fisheries, Indonesia Bureau of Fisheries and Aquatic Resources, National Freshwater Fisheries Technology Research Center, Philippines
Project Budget	\$97,708
Project Duration	01/07/2003 to 31/12/2004
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

The giant freshwater prawn (*Macrobrachium rosenbergii*) is the sixth largest (in volume) aquaculture species in Asia. It is grown widely in aquaculture farming, including areas well beyond its natural spread. It is both an important commercial species (notably in Taiwan, China, Thailand, India and Indonesia) and a significant cash crop for many poor farmers throughout Asia and the Pacific. Wild stocks are increasingly threatened in many parts of Asia. For example wild capture outputs in Indonesia fell by more than 1000 tonnes between 1989 and 1998. Wild capture and grow-out, rather than rearing from larvae in captivity, still form the backbone of many aquaculture farms. While the lifecycle of this species is well known and larvae can be relatively easy to produce in simple hatcheries, larval production and grow-out have not been successful everywhere.

Over-exploitation, environmental pollution and habitat loss have threatened wild stocks of *M. rosenbergii* in many parts of Asia, but little is currently known about the levels and patterns of genetic diversity that exist in wild stocks of the species. This knowledge is vital for developing appropriate wild stock management plans and as basic information for stock improvement programs for culture. The objectives of this project were to compile basic data on the levels and patterns of genetic diversity in wild *M. rosenbergii* stocks across the species natural range in the Asia–Pacific. In addition, the partner institutions in Indonesia and the Philippines would receive training in the analysis, interpretation and application of such data sets to increase their capacities to undertake further studies.

Project outcomes

As predicted from life history traits and the extensive natural distribution of *M. rosenbergii*, genetic diversity was extensive among wild stocks. The scientists identified two major sets of populations that may represent discrete ‘biological species’. These correspond to ‘eastern’ and ‘western’ forms of *M. rosenbergii*. The natural geographical boundary between the two forms corresponds with ‘Huxley’s Line’ (an extension of Wallace’s Line north into the Philippines archipelago). Wallace’s Line is widely recognised as a major biogeographical boundary passing through eastern Indonesia between unique floral and faunal (non-marine) assemblages that evolved independently in Gondwanaland and Eurasia respectively and that have come together as a result of past continental drift. Estimates based on a ‘Molecular Clock’ approach suggest the two forms have not shared a common ancestor for more than 5 million years. Currently, all farmed *M. rosenbergii* stocks around the globe with the exception of those in the Philippines, culture the western form of *M. rosenbergii*.

Significant divergence was also evident at finer spatial scales within the two major clades (a clade is a group of organisms descended from a common ancestor) discussed above. Analysis of divergence

among sampled wild stocks of the western form (Bangladesh, Thailand, Malaysia, Vietnam and Indonesia - excluding West Irian) indicated that Pleistocene fluctuations in sea levels have at different times either connected or isolated major drainages, and this is most likely the major factor that has contributed to the observed patterns of genetic diversity. When sea levels were lower (50 to 100 metres + at some stages during the Pleistocene) major river drainages now isolated by marine habitat were connected, and apparently permitted gene flow among *M. rosenbergii* stocks.

A major divergence was identified between western stocks north and south of a region in southern Thailand referred to as the 'Isthmus of Kra'. When sea levels were higher in the past, marine introgressions are supposed to have affected the Malay/Thai peninsula, converting it to an archipelago and providing a major barrier to local *M. rosenbergii* gene flow. The effective of this disruption to gene flow has meant that some populations that are now separated by as little as 100 km in this region last shared a common ancestor more than 1 million years ago.

Extensive divergence was also evident among wild stocks of the eastern form (Irian Jaya, PNG, Australia and Philippines). Four divergent lineages were identified, corresponding to clades from Western Australian (Kimberley region), northern Australian (Northern Territory and Gulf of Carpentaria), Irian Jaya and PNG (with the inclusion of northeast Cape York). As was the case for western form populations in Southeast Asia, the research team concluded that Pleistocene sea level changes that apparently altered connections among major freshwater drainages played a significant role in the evolution of the patterns of relationship in 'eastern' *M. rosenbergii* wild stocks.

Thus genetic divergence among modern wild stocks of *M. rosenbergii* is extensive, and most major modern freshwater drainage systems contain discrete sets of genotypes that do not normally have interchange (effective dispersal) even with adjacent drainages. Thus wild stocks in major freshwater drainages are essentially evolving independently. Since many cultured stocks world wide are considered to have been sourced originally from Malaysia (mostly culture stocks outside Asia), only a small fraction of the natural genetic diversity in this species to date has been exploited systematically for culture. The extensive genetic diversity identified in wild *M. rosenbergii* stocks thus provides a major resource for future improvement of culture stocks.

Project 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 Fax: 02 6281 8312 Email: john.doran@csiro.au
Project Web Site	http://www.ffp.csiro.au/
Collaborating Institutions	Global overseas collaborators, Global
Project Budget	\$2,094,461
Project Duration	01/01/2000 to 31/12/2004 (Project extended from 01/07/2004 to 31/12/2004)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

In many countries people now face severe shortages of wood and wood products – through physical scarcity or because access to existing forest resources is restricted by commercial interests or government policies. Inadequate fuelwood compels poor people to collect fallen leaves and twigs for fuel from plantations, thereby disrupting nutrient cycling processes and impoverishing the soil.

Overall demand for fuelwood in the developing countries is expected to increase at an annual rate of 1.1 per cent; meanwhile, forest cover is steadily declining (in continental Southeast Asia at an average rate of 1.6 per cent per year). Land degradation and other changes brought about by reduced forest cover are causing substantial social, economic and environmental problems. Remaining natural forests and plantation forests are under greater harvesting pressure.

In many developing tropical and subtropical countries Australian trees have been planted (and are still being planted) to deal with the demand for forest products. The species are popular because many of them perform well on degraded, infertile sites, can deal with wide variations in climate and grow rapidly when the water supply is good. In developing countries around the world there are now more than 13 million ha of eucalypts, 2 million ha of acacias and 1 million ha of casuarinas in plantations, with many more Australian trees in agroforestry settings or scattered plantings.

But failure to use the best germplasm, and poor matching of species to the sites and to suitable uses for the product have over time reduced the benefits of using Australian trees. This domestication of Australian trees (DAT) project helped devise strategies to create more productive and sustainable planted forests in developing countries, using carefully selected Australian tree species. The work followed on from the earlier 'Seeds of Australian Trees' project funded by AusAID and ACIAR.

The major project objectives were to support more effective domestication and use of Australian tree species in low-income developing countries through provision of certified seed, training, and technical advice on the domestication and best use of Australian tree and shrub species.

Project outcomes

The main components of the project were seed supply, provision of technical advice and literature, and training. Research seedlots were sent to 44 recipients in 20 countries between January and December 2004. Developing-country researchers also received 87 copies of scientific and technical publications. Courses in Sri Lanka and Vietnam trained participants in seed orchard management and seed technology for seed orchards, including seed quality issues, seed collection, processing and documentation. A training course in Guangzhou, China, introduced software and methods for analysis of advanced-generation breeding populations.

Genetic gain trials established in the Philippines, India, Sri Lanka, Thailand and Vietnam enabled researchers to compare the performance of seed collected from in-country seed orchards established and managed by DAT collaborators with the original natural provenances used to establish the

orchards as well as local commercial seed sources. These trials use large plot size (typically 36-tree or 49-tree square plots) and four or more replicates, in order to accurately rank the performance of the seedlots and determine whether trees grown from the seed orchard seedlots showed significant improvement in plantation performance. Two-year performance data from the genetic gain trials in the Philippines (*Acacia mangium*, *Eucalyptus urophylla*), Thailand (*E. camaldulensis*, two locations) and Vietnam (*A. auriculiformis*, *A. mangium*), and one-year performance data from Sri Lanka (*E. grandis*) were collated and analysed by partner organisations.

In summary, the studies found excellent performance of the orchard seedlots relative to natural provenance and commercial controls. The orchard seedlots were ranked best or close to best for height and diameter growth in all of these trials, and also displayed above-average survival. Treatment differences were statistically significant for most of the trials. For *A. mangium* in the Philippines the orchard seedlot had more than twice the 2-year conical stem volume of a locally used Mindanao land race of *A. mangium*, while in Vietnam the orchard *A. auriculiformis* had 38 per cent greater 2-year conical stem volume than the local commercial seed source, and significantly superior branching and stem straightness. In both these cases the orchard seedlots also significantly outperformed the natural-provenance controls, demonstrating that significant genetic improvement had been achieved in the orchards.

Partner research organisations in the collaborating countries are already using these results to promote the use of superior orchard seed over other local alternatives. Already in India small unreplicated demonstration trials of the orchard seedlots of *E. camaldulensis* and local alternative seed sources established on plantation company lands have led to strong commercial demand for seed from the DAT orchards.

Paclobutrazol treatment of eucalypt seed orchards in India, carried out during the project, led to substantial increases in flowering and seed production, and it is anticipated that this treatment will be used operationally to boost seed production of low-yielding species such as *E. tereticornis*. A new seed orchard of *E. tereticornis* was successfully established in Sri Lanka under the project, while in Vietnam clonal seed orchards of *A. auriculiformis*, *A. mangium* and *E. camaldulensis* were established in three locations across the country. The best 30 or so clones of each species, propagated from progeny trials, were established in a clone bank for intensive control-pollinated breeding, using clone bank technology transferred from CSIRO via the DAT project.

Project staff from CSIRO and from collaborating countries including China, Cambodia, India, Indonesia, Laos, Thailand, the Philippines and Vietnam attended a two-day meeting in Bangkok to review progress with domestication of key Australian species and plan for future collaboration after the conclusion of the project.

Project LWR/2000/084: Minimising the off-site impact of pesticides from agricultural systems — a risk based approach

Overseas Collaborating Countries	Philippines
Commissioned Organisation	CSIRO Land and Water, Australia
Project Leader	Dr Rai Kookana Phone: 08 8303 8450 Fax: 08 8303 8565 Email: Rai.Kookana@csiro.au http://www.clw.csiro.au/publications/general.html
Project Web Site	
Collaborating Institutions	University of the Philippines at Los Banos, Philippines CSIRO Mathematical and Information Sciences, Australia University of South Australia, Australia
Project Budget	\$399,888
Project Duration	01/01/2001 to 30/06/2005 (Project extended from 01/01/2004 to 30/06/2005)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

The project aims to develop modern risk-based approaches for reducing off-site impacts of pesticides applied to field crops, in order to protect human health, fisheries and aquatic ecosystems. This involves integrating information on pesticide use, site conditions, and the environmental fate and behaviour of pesticides in selected catchments in the Philippines and Australia. Scientists conducted a risk assessment of off-site impacts of agricultural systems, using tools such as CSIRO's Pesticide Impact Rating Index (PIRI), to integrate factors for use by water resource managers, policy makers and community organisations.

Project outcomes

New concepts concerning risk assessments for pesticide use were developed. Three separate booklets were used to collate much of the data that underpins the Pesticide Impact Risk Index (PIRI). The inventory used for PIRI was developed based on pesticides used and their application practices in differing land uses. This covered the Laguna and Lake Taal area of the Philippines and two Australian sites; the 6th creek sub-catchment of the Mt. Lofty Ranges (South Australia) and the Ord River Irrigation area (Western Australia).

At these locations pesticides were monitored at creeks and rivers. Through this monitoring the presence of some pesticides in sediments and water samples were identified. This formed the basis of the snapshot assessment to determine if these pesticides were moving off-site or not, but did not extend to loadings of pesticide levels in soils and water. Those pesticides identified will be the focus on any future work to minimise off-site migration.

Customisation of PIRI to conditions in the Philippines was undertaken. Local pesticide data was incorporated including its environmental fate (such as its half-life at local temperatures) and toxicity. A preliminary assessment of pesticide toxicity and impacts on water resources was also conducted. This was based on the levels of pesticide residues collected twice annually and then compared against data toxicity on selected local aquatic organisms collected during the project. One key finding to emerge was that pesticides detected in Philippine and Australian waterways were below levels that result in acute toxicity, but were of sufficient levels to cause chronic problems such as abnormalities in some fish species.

The management of pesticides based on matching risk ratings to land uses was defined. Pesticides were categorised into high, medium and low risk ratings, based, in part, on the likelihood of off-site transportation. In addition simple measures such as plugging leaking bunds in rice paddies were tested and recommended to minimise off-site transportation.

Philippine and Australian scientists developed an improved understanding of the environmental fate and ecological impacts of selected pesticides on land and water resources in the Philippines and Australia. This was developed from studies in Australia on the sorption (binding of one compound to another) behaviour of selected pesticides in tropical soils from Australia and the Philippines and temperate soils from the Mt. Lofty Ranges, Australia.

Eco-toxicological studies using species relevant to the Philippines provided valuable data for customising PIRI for conditions in the Philippines. For example, toxicity data set on several pesticides for a locally important fish species, *Tilapia* sp., is now available for use in risk assessment in the Philippines, rather than using data from the literature for Rainbow trout.

Projects under development

at 30 June 2005

Bilateral

ASEM/2003/053	Linking smallholder vegetable producers in the Philippines to urban markets
ASEM/2005/062	Linking smallholder vegetable producers in the Philippines to institutional markets in metro Manila – a scoping study
ASEM/2005/071	Disease control in Minanao vegetable farming systems
FIS/2003/033	Integrated fisheries resource management (Rinconada Lakes, Philippines and NSW Australia)
LWR/2004/069	Minimising agricultural pollution to enhance water quality in Laguna de Bay (Philippines) and Mt Lofty Ranges (Australia)
LWR/2004/078	Inabanga Catchment Management
LWR/2005/060	Soil and water management for fruit tree crops Philippines
LWR/2005/117	Income generation from irrigated horticulture on sloping lands in the Philippines – a feasibility study

Philippines consultations

18–20 March 2002

Priorities for collaborative agricultural research between Australia and the Philippines were discussed on 18–20 March 2002 at a consultation between ACIAR and representatives of relevant national and local Government Departments, private sector associations, national and regional research consortia and research organisations in the Philippines.

These priorities are not to be considered as officially sanctioned priorities of the Government of the Philippines. They are priorities expressed by participants at the consultation at a particular point in time. ACIAR will use them as a framework when assessing proposals for collaborative projects to be supported by ACIAR, subject to further advice and information from the Philippines.

Researchers intending to propose collaborative research projects with Philippines counterparts for ACIAR support should, in the first instance, approach one of ACIAR's Research Program Managers.

At the consultation, several overarching issues were identified. These included the need for research to underpin both the development and implementation of *policies that increase the efficiency of agricultural production and marketing*. There is a need to increase the *international competitiveness* of Philippines agriculture, and expand the markets for Philippine agricultural products and services, taking into account the impacts of trade liberalisation. Underlying competitiveness is the need for *improved agricultural productivity to raise rural incomes* - responding to market opportunities with higher quality commodities produced at a competitive cost. Specific opportunities may come through research for development and marketing of higher-value aquaculture, fruit, livestock products and processed foods. Improved productivity should not come at the expense of natural resources degradation, especially of uplands and fragile watersheds and coastal zones.

Research projects should be driven by design processes that include end-users and *address their needs*, be they farmers, processors of agricultural products or policymakers - active involvement of community groups in the districts where the research will be applied and of policy stakeholders in the projects will be encouraged. Project design should also accommodate challenges that have arisen from the *devolution of the management and governance of extension responsibilities* to local government units, and the comparatively poor research-extension linkages that may currently exist. Opportunities exist for *follow-up activities* that enhance the impact of earlier ACIAR projects.

Agreed priorities are listed under ACIAR thematic focus areas:

Meeting the escalating demand for animal protein (livestock and fisheries)

- Improvement of the productivity of smallholder livestock and aquaculture farming systems, including establishing appropriate complementarity with commercial systems
- Technologies and policies to meet livestock and fishery product quality and food safety requirements of markets
- Development of improved surveillance and management capacity for economically-important (including exotic) livestock and fisheries diseases
- Development of sustainable coastal aquaculture systems, including the integration of capture fishery/ culture systems
- Consolidation of available livestock and fisheries research knowledge for use by smallholders, extensionists and educators.

Improving the productivity and efficiency of food crop and forestry systems - Crop production, protection and postharvest technology

- Application of biotechnologies for the improvement of horticultural crops and coconuts (including transformation, bioinformatics and *in vitro* conservation)
- Development and application of diagnostic tools for major crop diseases
- Policy and regulatory standards for the management of pesticide residues and mycotoxins
- Optimisation of postharvest systems and equipment to improve utilisation of crops and byproducts

- Development of information modules and training systems to facilitate the uptake of crop production, protection and postharvest technologies.

Forestry and agroforestry

- Improved cropping and agroforestry options and land management systems for marginal and hilly lands
- Technologies for the mass propagation of genetically-improved forestry species.
- Community-based forestry enterprise development for wood and non-wood products.
- Technologies for quality improvement of timber products, including raw-material product matching and technologies for timber drying and processing.

Better environments from better agriculture

- Research to underpin groundwater management policies (including on saline water intrusion in coastal areas, fertiliser nitrate contamination and aquifer characterisation)
- Improved adoption of soil fertility management and soil and water conservation strategies at the watershed level
- Analysis of the impact of fast-growing trees on the availability and quality of water for agriculture
- Technical and economic analysis of the irrigation requirements of high-value fruit and forest tree plantings.

Linking Farmers to Markets (agricultural economics and policy)

- Analysis and development of market structures to increase smallholder profitability (including the roles of structural inefficiencies, farmer organisations, smallholder-trader relationships and credit and market choices and power in price formation)
- International competitiveness and industry policy research for particular Philippine agricultural commodities (including an analysis of appropriate product processing standards and opportunities for value addition, niche production and marketing)
- Domestic and international commodity production forecasting, application of economic modelling of supply and demand
- Public education and policies for application of biotechnology in agriculture
- Economic assessment of the market potential of individual GM crop products, addressing cost premiums and required price differentials and the distribution of technology returns
- Comparative assessment of the efficiency and effectiveness of different models and mechanisms for the delivery of agricultural extension services in the Philippines
- Application of information and mapping systems to assist in agricultural planning and technology localisation
- Valuation of environmental services required for sustainability of agricultural production.

ACIAR publications

This list is a selection of titles from ACIAR's range of scientific publications that are relevant to the Philippine's agricultural research and development sector. Hard copies are available by emailing comms@aciarc.gov.au, or may be requested through ACIAR's Philippines office. Publications may also be downloaded from ACIAR's website, www.aciarc.gov.au.

Monographs

- 48 Nutrient Disorders of Sweet Potato
- 51 Biological Control of Insect Pests: Southeast Asian Prospects
- 54 Survey Toolbox for Livestock Diseases: practical techniques for developing countries
- 58 Understanding Animal Health in Southeast Asia: Advances in the Collection, Management and Use of Animal Health Information
- 75 Socio-Economic Evaluation of the Potential for Australian Tree Species in the Philippines
- 83 How to Unravel and Solve Soil Fertility Problems
- 94 Survey Toolbox for Aquatic Animal Diseases: A Practical Manual and Software Package
- 96 Rats Mice and People: Rodent Biology and Management
- 97 Effects of Globalisation and Economic Development on the Asian Livestock Sector
- 100 Field Methods for Rodent Studies in Asia and the Indo-Pacific
- 110 Advances in Grouper Aquaculture
- 111 High-yielding Anthracnose Resistant *Stylosanthes* for Agricultural Systems
- 112 Landcare in the Philippines: Stories of People and Places
- 113 Worm Control for Small Ruminants in Tropical Asia
- 114 Diversity and Management of *Phytophthora* in Southeast Asia
- 119 Guidelines for Surveillance for Plant Pests in Asia and the Pacific

Proceedings

- 33 Sustainable Agriculture on Marginal Uplands of Southeast Asia
- 45 Bacterial Wilt
- 50 Postharvest Handling of Tropical Fruit
- 57 Leucaena: Opportunities and Limitations
- 61 Agricultural Impacts on Groundwater Quality
- 63 Matching Trees and Sites
- 71 Grain Drying in Asia
- 74 Sustainable Parasite Control in Small Ruminants
- 81 Disease Control and Storage Life Extension of Fruit
- 70 Management of Clay Soils for Rainfed Lowland Rice-based Cropping Systems
- 74 Sustainable Parasite Control in Small Ruminants
- 94 Classical Swine Fever and Emerging Diseases in Southeast Asia
- 97 Hypsipyla Shoot Borers in Meliaceae
- 100 Quality Assurance in Agricultural Produce
- 105 Postharvest Handling of Fresh Vegetables
- 106 Water Policy Reform: Lessons from Asia and Australia
- 108 Development Strategies for Genetic Evaluation for Beef Production in Developing Countries
- 119 Agriproduct Supply Chain Management in Developing Countries
- 120 Spiny Lobster Ecology and Exploitation in the South China Sea Region

Technical reports

- 08 New Technologies for Rainfed Rice-based Farming Systems in the Philippines and Sri Lanka
- 13 Rainfed Rice Production in the Philippines: a combined agronomic/economic study of Antique Province
- 18 Post-Flask Management of Tissue-cultured Bananas
- 30 A Review of the Biology and Management of Rodent Pests in Southeast Asia

55 Chromolaena in the Asia-Pacific Region

Research Notes

24 Bringing trees back in the Philippines*

26 Non-chemical Control of Rodents in Lowland Irrigated Rice Crops

ACIAR Working Papers

53 Priorities for Pig Research in Southeast Asia and the Pacific to 2010

54 Mud Crab Aquaculture in Australia and Southeast Asia

56 Agricultural Research and Poverty Alleviation: Some International Perspectives