Country Profile

Philippines

November 2006

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

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Preface

The ACIAR Country Profiles are designed to give a snapshot of the collaborative research being carried out between Australia and our 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 2006. At that time there were 17 active bilateral projects and two active multilateral projects, the latter being led by international agricultural research centres. There were another 13 bilateral projects and two multilateral projects under development, many of which are expected to start in 2006–07 financial year.

This publication also sets out the key outputs and outcomes from the 11 bilateral projects and one multilateral project that have been completed since 30 June 2006.

In addition to these project summaries, the publication includes an extract from ACIAR's 2005–06 Annual Report covering the Philippines, our near-term program as outlined in the 2006–07 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 updates this profile each year and distributes 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.

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Director

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November 2006

Philippines Report 2005–06

(extract from ACIAR Annual Report 2005–06)

Active projects in 2005–06	33
AOP budgeted expenditure in 2005–06	$2,581,000
Actual bilateral country expenditure in 2005–06	$2,829,547
Bilateral country expenditure in 2004–05	$2,295,395
Bilateral country expenditure in 2003–04	$1,852,285

Key performance indicators	**Performance 2005–06**
• Significant involvement of farmer groups and local government in participatory research and extension in ACIAR projects	ACIAR projects ASEM/2002/051, ASEM/2003/009, ASEM/2005/062, LWR/2001/003 and SMCN/2000/114 have the involvement of local government and farmer groups in participatory research and extension.
• Systematic analysis of opportunities to extend the results of past ACIAR-funded research completed	Systematic analysis completed in preparation for March 2006 ACIAR–Philippines consultation, and opportunities discussed with Philippines counterparts. New Community Agricultural Technology Program initiated to build upon past ACIAR-funded research.
• Policy papers delivered to key ministry planning groups on options for enhancing delivery of extension services in the Philippines	Project ASEM/2001/108 presented extension policy papers to forums of high-level policy-makers. The Department of Agriculture is currently undergoing a major restructuring and the outputs of the project are being considered in these deliberations, most directly via members of the project steering committee.
• Routine use of ruminant performance improvement systems by the dairy industry	An integrated pedigree/performance database for carabao and dairy buffalo was transferred to the Philippines Carabao Centre. Its staff received additional training in the operation of this database and prepared and presented a workshop relating to data collection and interpretation of 'estimated breeding values' (EBVs) for carabao and dairy buffalo raisers. A strategy for the Philippine carabao milk evaluation system has been developed and testing of the data structure commenced during 2005–06.
• Community adoption of better watershed management practices in Bohol	Government and NGO agencies in the watershed are aware of project's recommendations and have incorporated them into their planning; there is limited implementation on-the-ground. ACIAR support has three years to run.
• Initial assessment of the sustainable use of shallow groundwater for intensification of cropping in northern Luzon	Volumes of sustainable yield from shallow groundwater sources have been estimated in northern Luzon for the first time.

Key performance indicators	Performance 2005–06
• Initial on-farm trials established for improved mango integrated pest and disease management approaches	Integrated mango pest management on-farm trial sites (HORT/2003/071) established on two farms in each of the provinces of Guimaras, Davao de Norte and Davao de Sur. Several on-farm trial sites were also established to improve control of mango pre- and post-harvest diseases using natural defence promoters, a range of 'soft' chemicals and modified plant nutrition practices.
• Description of the significance of migration and/or off-farm employment on roles of women and appropriate technologies in Philippine mixed farming systems	A progress report summarising the results of a major survey on the significance of migration/off farm employment published by IRRI. It highlighted significant differences between Thailand, Vietnam and the Philippines. Differences particularly centre on migrant work options for Philippine women and in-country options in the other two countries.
• 40% of new projects designed to have significant farmer or policy-maker impacts within 5 years of completion	Two of three new Philippines projects assessed by members of the In-House Review Committee designed to have significant impacts within 5 years of completion (Projects: LWR/2004/078, ASEM/2003/053).

Position

An ACIAR–Philippines country consultation held in March 2006 established new priorities and sought to continue to invest in opportunities to enhance farmer uptake of the results of current and past ACIAR-funded projects. ACIAR and its Philippines partners have increased the emphasis on better understanding of extension processes and involving farmer and community groups in projects.

It was agreed that the overarching issue of ACIAR cooperation was to increase the productivity, marketability and international competitiveness for Philippine agricultural products, taking into account the impacts of trade liberalisation. Underlying this competitiveness is the need to improve agricultural productivity, to raise rural incomes through more effective extension of research results, and to respond to market opportunities with higher quality commodities produced at a competitive cost. There is an ongoing shift of project locations into particular provinces within Mindanao and the Visayas (along with a limited number of provinces in Luzon), while maintaining strong links to research and development expertise in Manila and Los Baños.

ACIAR and AusAID have initiated some jointly funded activities in the areas of mango pest management and postharvest technology, and have cooperated to scale up the Landcare approach to farmer-driven natural resource management. A program of small activities that link ACIAR-generated technologies with non-government organisations involved in the AusAID-funded Philippines–Australia Community Assistance Program has also been initiated.

Achievements

The Philippines program continued to support projects that develop technologies with potential to increase farmers' productivity and incomes. There also remained a strong focus on improving market chains and facilitating market access for poorer farmers. One such project has helped to improve production efficiency, quality and marketability of the produce of **vegetable growers in Mindanao**. The box below gives details of this successful initiative.

The community based **Landcare movement** is helping farmers to conserve their soil, meaning that they can maintain the farming activities they know well while adopting new practices to improve their livelihoods. Researchers working with community groups achieved successes in Mindanao, and the ideas and practices of Landcare spread from Claveria in the north to Lantapan in the centre and Ned in the south. Now an ACIAR-AusAID project is strengthening the work in Mindanao and extending the outcomes to other parts of the Philippines. Adapting the criteria developed by former ACIAR John Allwright Fellow Dr Delia Cacatucan to determine the best sites for promoting Landcare, the project team has identified new sites in Mindanao, Agusan del Sur and Bohol.

In another community-based project on the island of Bohol, researchers have found ways to **better manage the catchment area of the Inabanga River**. National-level management agencies, local government, NGOs and farmer groups are putting to use the knowledge gathered at both local and watershed scale about soil erosion and runoff, water quality, crop production and water management. Planned demonstration farms and learning centres, linked with ACIAR Landcare activities within Bohol, are anticipated to further strengthen soil and water management.

A project to enhance agricultural production by sustainable **use of shallow groundwater** has focused on two pilot sites within neighbouring municipalities of the province of Ilocos Norte in the north-western tip of Luzon. Researchers have now assessed groundwater supply and demand at these two sites and measured water quality. Topographic surveys of the study area have been completed, and the locations of all existing shallow tube wells and dug wells have been mapped. Extensive monitoring equipment is in place to establish the volume of fresh water within the aquifers, assess groundwater recharge and determine sustainable levels of groundwater use. The project team is also studying the problems of saline intrusion into the aquifers. As well, a socioeconomic survey involving around 120 respondents has been undertaken; the survey also provided information about the areas currently planted to various crops. A soil survey of the region, now complete, will assist in defining land suitability for expansion of current areas of cropping.

Another project aims to ensure a more secure financial future for existing and intending **smallholder tree farmers in the Visayas**. Smallholders had been encouraged to enter the industry and planted trees 8–10 years earlier, but they were now discouraged by the lack of markets or, if a market was found, by very low prices. Paradoxically, saw millers claimed they could not get supplies. Project strategy is to assist the Department of Environment and Natural Resources (DENR) to streamline tree registration and log transport, to assist smallholder tree growers to satisfy market requirements and improve productivity, and to identify and promote livelihood systems and policies for forestry enterprises more attuned to smallholders. Already a project-published manual on tree registration, harvesting, transport and marketing policies in private lands has been officially endorsed by DENR and is being widely distributed. The project is helping to improve the silvicultural skills of farmers. Tours have taken farmers to demonstration sites to learn more of the key information about silviculture. Another initiative is a pilot program testing cost-effective ways to link buyers and sellers of timber.

Work is under way to harness the **potential of bamboo** by optimising its cultivation and the management of plantings to produce more shoots (used in Asian cooking) and stronger poles (an excellent timber substitute for construction). There is also a need to find new uses for this versatile plant. Project scientists have spent the past four years working with farmers in Mindanao to rejuvenate old and abandoned plantations while testing an extensive range of techniques for optimising productivity and maintenance. Results indicate that the quality of bamboo culms and shoot harvests can be significantly improved. The project has facilitated establishment of businesses using project-grown bamboo to make floor tiles.

The reliance of rice farming on **herbicides to control weeds** has resulted in herbicide resistance building up in some weed species. An ACIAR project introduced an integrated weed management package to lower herbicide applications. Trials in farmers' fields have been so successful that the project has had difficulty maintaining controls—the farmers, having seen the benefit, want to treat all fields in the same way. Researchers therefore established comparison trials in fields outside the project area—these can be compared with the project controls as a way of detecting when management practices digress from the project schedule.

The **mango industry** in the Philippines is affected by numerous pests. Control measures to date have been largely unsuccessful, and unregulated use of pesticides has affected the mango export industry. A project with funding from ACIAR and AusAID is testing integrated field management practices, including improved monitoring, control and detection of pests and introduction of integrated pest management regimes. A survey is collecting information on farmers' practice and proposed management intervention at pre-bearing stage. Data are also being obtained on yield and production costs. When it was realised that those monitoring the pests needed help to perform the task effectively, the team undertook to develop a pest monitoring kit.

The project will contribute expertise to investigate the problems caused by two destructive pests, mango pulp weevil and seed weevil, and to test control strategies using chemical and particle films. As well, poor packaging and handling practices have been identified as major causes of quality loss in mangoes. Changing practices requires some parts of the industry to adopt significant changes, and the project is developing strategies to facilitate this process.

Papaya ringspot virus (PRSV) has caused large papaya production losses in the Philippines and elsewhere in Asia. There is no inherent resistance known in cultivated crops and research efforts over the past decade have attempted to introduce resistance from related species. This has been achieved, and further work is now attempting to produce commercially useful resistant lines by backcrossing the interspecies lines with known high-yielding cultivars. One backcrossed line, the first conventionally bred PRSV-resistant backcross in the Philippines, is considered a significant breakthrough.

In the Philippines infestations of **bacterial wilt** on vegetable crops were so bad that farmers resorted to bleach and cement to combat them. An ACIAR project has determined that the **biofumigation** properties of brassica species (isothiocyanate chemicals released as the plants decompose) help to suppress outbreaks. There are many different brassicas, and varieties differ considerably in the level of disease-suppressing chemicals they produce. The project has identified some of the standout performers, and also determined the most effective means of extracting the chemicals from the plant. The most promising treatments (using radish, mustard and broccoli) have reduced bacterial wilt by 50–60 per cent. This approach is now being utilised more widely with Mindanao farmers who are participants in the Landcare program.

Philippines Plan 2006–07

(extract from ACIAR Annual Operational Plan 2006–07)

GNI per capita[1]	
Population[2]	83.1 million
Population 20215/2050[3]	96.8 / 127.1 million
Active bilateral projects	13
Active multilateral projects	2

Bilateral actual 2004–05	$2.24m
Bilateral forecast 2005–06*	$2.58m
Bilateral budget 2006–07*	$3.21m
Bilateral + Multilateral budget 2006–07	$3.63m

*Includes AusAID funding: $0.33m (actual 2004-05), $0.35m (budget 2005–06), $0.32m (budget 2006–07).

Medium–term Strategy

The main aim of ACIAR cooperation is to assist the Philippines to increase the productivity, marketability and international competitiveness 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 research results and 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, horticultural, forestry and livestock products 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. Efficient use of water will assume increased importance. ACIAR's Philippines program will have an increasing emphasis on involvement of local partners such as local government units, non-government organisations (NGOs) 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. Linkages of regionally-based delivery organisations and research organisations and policymakers based centrally in Manila and Los Baños will be fostered. ACIAR's program will increase its emphasis on the Southern Philippines, within a limited number of focal provinces in Regions X and XI (Mindanao) and Regions VI, VII and VIII (Visayas).

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

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

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

Key performance indicators (2006–07)

- Ongoing involvement of farmer groups and local government in participatory research and extension in ACIAR projects
- Priorities from 2006 Philippines–ACIAR country consultation addressed in development of new themes and projects
- Community Agricultural Technologies Program (CATP) commenced and at least six new collaborations between Philippines ACIAR researchers and NGOs formed
- ACIAR–AusAID Landcare project farmer groups established in Agusan del Sur and Bohol implementing livelihoods diversification approaches
- 40 per cent of new projects to have significant farmer or policymaker impacts within five 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 and giant clam culture was also important. During the 1990s research cooperation shifted towards livestock management and biotechnology. A shift in project location, to emphasise the poorer areas of Mindanao and the Visayas but maintaining strong links to research and development expertise in Manila and Los Baños will continue.

Improving uptake of research in the Philippines is a major 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 and in scaling out of the Landcare approach to farmer–driven natural resource management. During 2006 a new initiative (CATP) to link ACIAR-generated technologies and Philippines research providers with non-government and community-based organisations commenced.

One major international agricultural research organisation, the International Rice Research Institute (IRRI), is headquartered in Los Baños, Philippines. ACIAR provides core funding to IRRI and also supports additional initiatives aimed at maintaining rice productivity. The regional office of the International Network for the Improvement of Banana and Plantain (INIBAP), a network of the International Plant Genetic Resources Institute (IPGRI), is also headquartered in the Philippines.

Relationship to the AusAID Philippines strategy

The AusAID Philippines country strategy has three key objectives: to remove impediments to broad-based growth through stronger economic governance; to improve security and stability through counter-terrorism capacity building, support for the Mindanao peace process, and humanitarian and emergency assistance; and to improve the living standards of the rural poor in the southern Philippines. AusAID assistance to raise rural incomes includes programs to improve local government planning and service delivery, rural production and marketing, and basic health and education services as well as vocational and technical training.

ACIAR's Philippines program underpins key aspects of the first and third objective. A new subprogram to commence in 2006/07 'Addressing regulatory, policy and technical constraints to the adoption of research outputs' has a strong economic governance aspect, while ACIAR's rural development focus in the Philippines is built around increasing the productivity, marketability and international competitiveness for Philippine agricultural products. The major emphasis for new project development is the southern Philippines.

Key Program Managers

Dr Ken Menz, Agricultural Systems Economics and Management
Mr Barney Smith, Fisheries
Mr Les Baxter, Horticulture
Dr Ian Willett, Land and Water Resources
Dr Jeff Davis, Policy Linkages and Impact Assessment

Country Manager

Ms Cecilia Honrado, ACIAR Country Manager, Philippines

Active projects

at 30 June 2006

Bilateral

Multilateral

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, Centre for Subtropical Fruits, Australia
Project Leader	Noel Vock Phone: 07 5444 9614, Mobile 0412 119 048 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 University of the Philippines at Los Banos, Philippines
Project Budget	$1,416,446
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 (LGUs) 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 from the previous project that included 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 2 (01/07/2005–30/06/2006)

In the Philippines component, progress against the objective of strengthening institutional support structures for Landcare included:

- The working partnership with the Landcare Foundation of the Philippines Inc (LFPI) was continued and a more formal involvement of the Foundation in the project's institutional research achieved. Data gathering and preliminary documentation of the research were completed.

- The Landcare Coordinators Network (LCN) continued to develop with the conduct of three workshops and progress of a number of collaborative cross-site initiatives including a Landcare Peoples' Organisation Forum in December. Processes to evaluate the effectiveness of the Network were developed and commenced with preliminary data gathering and documentation of the research completed.

Progress against the objective of sustaining and scaling up adoption of conservation farming systems and diversified livelihoods included:

- Fifty-five major training and networking events were facilitated or provided across the five sites. In the area of diversification of livelihoods these included: 1) training and exposure to expertise in nursery management; 2) the production of forage, high value vegetables, fruit trees (durian, lanzone, rambutan, mangosteen), livestock (goats, poultry), coffee, coconut, abaca, bamboo, mushrooms, medicinal plants, bananas, wood products and fish; 3) integrated crop production. In the area of conservation farming systems the events included training in soil and water conservation, agroforestry, permaculture, soil testing, integrated pest management, biodynamic production systems, natural farming technologies and vermi-composting.

Progress against the objective of analysing and evaluating impacts

- The process documentation system developed in the previous year was implemented at all sites with Landcare Coordinators capturing issues of importance and reflections on progress through the quarterly reporting and nine-monthly review workshops.

- The research on institutional support structures for Landcare, including the Landcare Foundation, the Landcare Coordinators Network and selected case studied organisations, was largely completed and analysis and documentation is now in progress. Preliminary findings highlight the importance of key factors such as commitment, competence, leadership, incentives and effective partnerships in institutional success.

- A major focus of site teams during the year was the profiling of adoption data. Creative methods for collection of adoption data were implemented, including diagnostic cards and incentives to facilitate more rapid collection. An encouraging feature was the involvement of personnel from LGUs, Landcare associations and NGO collaborators in the collection of adoption data. Adoption of Landcare technologies was again shown to be significant, with over 1300 farmer adopters profiled in the established Misamis Oriental site, and over 150 in the new Bohol site.

Progress in the coordination and management of the project

- A major project team review workshop was conducted in Bohol in November 2005, with more than 30 personnel participating. Project progress for the first nine months was reviewed and forward work plans determined for the next nine months. Training on extension methods was provided to Landcare Coordinators prior to the workshop and re-echoed to the Landcare Assistants during the workshop. A meeting of the Project Management Committee was held in conjunction with the workshop, enabling clarification of cross-agency issues and resolution of some conflicts.

- An evaluation of the project 'e-zine' *newsMATE* was completed, with the survey showing a high level of support for and satisfaction with the concept.

- A project website and internal web portal www.landcaremates.org was completed and made operational. A start was also made on a complementary web-based management system for project images.

- The conduct of the review workshop in Bohol facilitated the interface between project teams from the Landcare and ACIAR Bohol Watershed projects. Seven personnel from the latter project attended part of the review workshop and the two teams undertook a joint field trip to project sites in Alicia and Pilar.

- A new component of research was added to the project in mid 2006, with the inclusion of research on interfacing vegetable integrated crop management technologies with Landcare groups in the South Cotabato and Bukidnon sites. The component brought Ms Valeriana Justo into the project team and the University of Philippines Los Baños (National Crop Protection Center) into the project partnership.

For the Australian component, progress against objectives included:

- scoping of project and engagement with stakeholders;
- characterisation of regional landscape and rural production area of Sunshine Coast, Qld;
- survey of landholders within selected study areas to determine needs and aspirations;
- development, analysis and testing of selected processes for landholders in study areas;
- identification and exploration of models of economic, social and environmental cooperation between landholders.

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	$833,024
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;
- distill 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;
- develop and implement strategies to better match forecasts with decision maker's needs.

Project progress

Year 1 (01/01/2005–31/12/2005)

The first objective of the project was to work with PAGASA (Philippine Meteorological Bureau) to deliver and communicate the basis of seasonal climate forecasts. This is foundational to any future work on valuing seasonal climate forecasts. The communication between climate science and agricultural decision makers has been possible through the close interaction between PAGASA, PIDS and Leyte State University (LSU). Workshops have been held at PIDS office in Manila (April 21), Leyte State University, Baybay (June 30), and Malaybalay City, Bukidon (December).

One of the tools that PAGASA has used to explore the relationship between tropical sea surface temperatures and Philippine rainfall has been the international version of RAINMAN, a product of a previous ACIAR project. This has been valuable for showing where and when the forecasts have statistical skill. The interaction between PAGASA and PIDS has resulted in a number of non-technical publications that explain the scientific bases behind climate outlooks—for example how ENSO influences the Philippines and how this makes forecasting the season more reliable in certain parts of the country at certain times of the year.

How to match with decision making the information climate science can offer was much discussed—within regular project team meetings between the Philippine partners and during trips from Australian partners to the Philippines in March (project initiation), July (project launch) and October. Further opportunities were available when Philippine partners from PIDS and LSU visited Australia to take part in the economist planning meeting of NSW DPI economists held in Trangie, NSW in November 2005.

An encouraging aspect of the project has been the high level Philippine government support of the project through membership of the steering committee. This support was evident at the project launch by the Australian Ambassador Anthony Hely on July 27. Over 70 representatives attended the launch from government, farmer organisations, universities and industry. The main organisations represented (in addition to PAGASA, PIDS and LSU) were the National Irrigation Administration (NIA), The National Food Authority (NFA), the National Economic and Development Authority (NEDA), the Southeast Asia Research Council for Agriculture (SEARCA), the International Rice Research Institute (IRRI) and the University of the Philippines Los Baños. The launch received a high level of media coverage and provided an opportunity to draw attention to a website for the project (http://dirp3.pids.gov.ph/ACIAR).

Fundamental to the project in both Australia and the Philippines is the notion that economic frameworks for valuing uncertain seasonal forecasts will assist the communication process. To value SCF, a particular decision must be analysed and the benefits of a forecast calculated over time. Four case studies were started in the first year of the project as a means of ensuring that the theory and modelling is grounded in real decisions. From these case studies we hope to determine a potential value of SCF (desktop analysis) and the actual value when all the complications and restrictions are taken into account.

In the Philippines, the first case study was set up to examine the importation of rice by the National Food Authority. In discussion with decision-makers this was expanded to include the purchase, storage and distribution of rice. The second case study is at a farm level and examines decisions dryland corn farmers may make about cropping intensity, variety, fertiliser and sowing density.

The documentation from PAGASA of the status of climate data in the Philippines is a valuable resource for both this project and other work on managing climate risk. The information on the skill of the forecasts using RAINMAN provides a sound basis for valuing SCF in the project. The workshops in the provinces (Leyte and Bukidon) and the accompanying material explaining ENSO are important background for later work on valuing and using SCF within the project.

In Australia one case study has examined crop choice on the Liverpool Plains in northern NSW where farmers are presented with a climatically risky decision whether to sow a wheat crop in winter or continue the fallow to store more moisture for a subsequent sorghum crop. The second case study examines decisions about stocking rate on large wool-growing properties in the rangelands of western NSW.

Although we are using case studies, we also aim to provide generic guidelines on valuing seasonal climate forecasts. To that end we have produced a number of Excel-based spreadsheets with accompanying documentation. Two versions have been produced in Australia and one in the Philippines. These are not aimed at decision-support systems for growers but rather frameworks for thinking through the value of SCF. An example of such a simple decision tree for nitrogen decisions on wheat was presented to the WMO Expert team on Weather Climate and Farming at Geneva, November 2004

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, Australia
Project Leader	Dr David Pannell Phone: (08) 9844-8659 Fax: 0895448659 Email: dpannell@uwa.edu.au
Collaborating Institutions	Philippine Rice Research Institute, Philippines CSIRO Sustainable Ecosystems, Australia
Project Budget	$508,091
Project Duration	01/07/2004 to 30/06/2008
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Direct seeding as a method of crop establishment in rice is increasingly common in the Philippines and throughout Asia generally. Concomitant with this shift, however, is a more complex weed problem faced by farmers. Herbicide application has become their first line of defence against weeds. There are two to three rice seasons in the Philippines and hence, farmers spray herbicides up to a maximum of six times per year. This intensive and prolonged herbicide application can cause shifts in weed populations and the development of herbicide resistance is a potential problem associated with prolonged usage of a single type of herbicide. However, there are limited data available in the Philippines regarding herbicide use, weed shifts and herbicide resistance.

This project is examining weed management options, based on scenarios and modelling 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;
- assessing the status of herbicide resistance in rice weeds in the Philippines.

Project progress

Year 2 (01/07/2005–30/06/2006)

Objective 1. To sample and document farmer's current weed management practices, perceptions (including HR and health risks due to herbicide) and information sources in relation to direct seeded rice in the Philippines.

The results of a survey of 400 rice-growers in two major direct-seeded rice provinces, Nueva Ecija and Iloilo, has highlighted the trend towards greater herbicide reliance and important factors to consider in the R,D&E for integrated weed management. Results showed that almost all of farmers' current weed management practices involved a combination of cultural practices and herbicide use. But, if water availability became a problem, farmers failed to do good land preparation and tended to use more herbicides to control weeds. It was observed that farmers are using herbicides that have a higher risk of developing herbicide-resistance. Most farmers were concerned about possible environmental and health hazards associated with herbicide use. None were aware of the possibility of herbicide resistance development from continual use of the same herbicide. Farmers relied on extension personnel from both the government and the chemical companies, and other farmers for their information about weed management.

Objective 2. To test, evaluate and adapt a promising (low herbicide) direct seeded rice production method in farmer's fields in the Philippines.

Participatory on-farm trials have now been running for several seasons at 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 strategies have been tested side-by-side with the farmers' current weed management practice (Farmers' Practice plots). Better weed control, increased yields, and higher profits were obtained during the Wet Season (WS) 2005 and Dry Season (DS) 2006 with the use of integrated weed management as compared to current farmers' practice. These were consistent with the results obtained during the first cropping season (DS 2005). The on-farm trials will continue in further seasons and be adapted to local situations in collaboration with farmers and extension workers. Issues to be addressed in further on-farm trials include: the need for an adapted strategy for farms with less reliable water availability; options for a reduction in land preparation time; and row seeding. After successful trials, uptake by the local farmer group members is now beginning to be observed.

Objective 3. To assess the status of herbicide resistance in rice weeds in the Philippines.

The project established a herbicide resistance testing procedure through PhilRice, and via a field survey and a national network of extension/agronomy agents was able to screen a number of populations of major weeds for resistance to important herbicides. The exercise confirmed the existence of the first cases of herbicide resistance in *Echinochloa* spp. to herbicides butachlor and propanil in the Philippines and has greatly increased awareness of resistance risks and the ongoing capacity to confirm and characterise further cases.

Objective 4. To develop an economic framework for policy analysis of herbicide resistance and weed management issues in the Philippines and Australia.

The survey of growers in the Philippines highlighted the real and perceived likelihood of weed mobility across and between properties. Together with the increasing level of costly forms of resistance in Australian grain growing, this has made research into the economics of herbicide resistance management in the presence of weed (and resistance) mobility a priority. Results from economic analyses so far have begun to demonstrate: the reduced incentive for investment in resistance prevention when gaining resistance from a neighbour is likely; the importance of determining actual resistance risks; and the economic benefits of preventing mobility.

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 under-utilised 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 (DENR) 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;
- identify and promote livelihood systems and policies which incorporate forestry and recognise the socio-economic circumstances of smallholders.

Project progress

Year 1 (01/01/2005–31/12/2005)

The project commenced on 1 January 2005, with the official signing of the documents on April 7, 2005 in Manila. A project launch was held at Leyte State University on February 11, 2005, followed by a two day project planning workshop attended by 29 participants including researchers from The University of Queensland, Southern Cross University an Leyte State University. At this workshop, detailed research plans were presented by the lead Filipino and Australian researchers and critically discussed. At the workshop, the DENR Regional Director agreed to second two DENR staff, based in the ACIAR office at Leyte State University, full-time to the project. A comprehensive planning workshop proceedings was subsequently produced and distributed.

During the year significant progress was made towards the project objectives. The first objective of the project is to assist DENR to overcome policy implementation constraints to tree registration and log transport. During 2005 we worked closely with DENR staff to identify key constraints and determine how to overcome them. As part of this process we held one policy workshop and two action research workshops involving DENR and ACIAR staff. Significantly, a primer on tree registration, harvesting, transport and marketing policies in private lands was developed and validated during further workshops and meetings involving DENR staff. The primer has now been officially endorsed by DENR Region 8 Executive Director. Distribution of the Primer commenced in January 2006.

The second objective of the project is to assist tree growers to satisfy market requirements and improve productivity. An extension program is being developed and trialled which aims to test mechanisms to improve the silvicultural skills of farmers. As part of this program, the use of 'bus tours' taking smallholder tree-farmers to demonstration sites in order to delivery key information about silviculture has been developed. During 2005, two pilot tours were undertaken and their effectiveness is currently being assessed. In addition, a pilot program involving cost-effective ways of linking buyers and sellers of timber has commenced.

A key part of Objective 2 is to identify the market requirements for timber. A number of interrelated activities commenced in this area—a timber enterprise survey was finalised and interviews have commenced; a detailed assessment of the current timber resource on Leyte is under way, with field teams measuring both timber quantity and log quality from existing tree farms. As part of Objective 3 we are identifying and promoting livelihood systems and policies which incorporate forestry and which recognise the socio-economic circumstances of smallholders. During 2005 we designed a socio-economic survey to collect the necessary data. All tree-farmers who have their tree farms measured as part of activities conducted as part of Objective 2 will be approached to complete a questionnaire.

ASEM/2005/062: Linking smallholder vegetable producers in the Philippines to urban markets—a scoping study

Overseas Collaborating Countries	Philippines
Commissioned Organisation	Curtin University of Technology, Agribusiness Marketing (Horticulture), Australia
Project Leader	Dr Peter Batt Phone: 08 9266 7596 Fax: 08 9266 4422 Email: p.batt@curtin.edu.au
Collaborating Institutions	University of the Philippines, Diliman, Philippines
Project Budget	$93,535
Project Duration	01/11/2005 to 31/07/2006
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

Increasing urbanisation in the Philippines and through South East Asia requires the development of market linkages between consumers in the cities and smallholder vegetable growers in agricultural regions. A number of regions of the Philippines, in particular Luzon and poor areas of Mindanao, can produce good quality vegetables, however quality is inadequate by the time vegetables reach urban consumers, especially at the upper end of the market. This project will undertake preliminary investigations into the issues of enhancing quality of smallholder vegetable produce, product aggregation methods, contractual/quality/price transmission issues and the role of market intermediaries.

Project progress

First progress report due in 2006.

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	$399,533
Project Duration	01/07/2003 to 31/03/2007
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

Illegal, unreported and unregulated (IUU) 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 incidence 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 involving Indonesia and the Philippines, and in so doing, implement the recommendations of a 2001 ACIAR Small Project.

Project progress

Year 3 (01/07/2005–30/06/2006)

The reporting period of 2005–2006 involves the implementation of the final phase of the project. Substantial progress has been made in this period on two areas. The first progress involves the conduct of a bilateral workshop on IUU fishing, which is related to the implementation of the last component of the project on the development of a regional framework for combating IUU fishing in the Sulawesi Sea.

The conclusion of the national workshops on IUU fishing in Indonesia and the Philippines in the last reporting period clarified some of the issues that would need to be addressed by the two countries to effectively address the problem of IUU fishing. These workshops served as the precursors to the bilateral workshop on IUU fishing which was held in June 2006. A planning meeting was held in March 2006 in Singapore prior to the bilateral workshop on IUU fishing. Two representatives from partner institutions in Indonesia and the Philippines attended the meeting to discuss the themes, expected outcomes, and preparations needed for the bilateral workshop.

The Bilateral Workshop on IUU Fishing aims to assess the IUU problems in the Sulawesi Sea, explore options for effective implementation of measures to address the problem, and develop a template for a regional plan of action. During the bilateral workshop, Indonesia and the Philippines provided presentations and compared national fisheries laws and regulations, licensing systems, monitoring, control, and surveillance (MCS), and data collection systems. The status of stocks and IUU fishing issues in the Sulawesi Sea were also discussed. As a result of the discussions a framework for cooperation to address IUU fishing in the Sulawesi Sea was agreed by the two countries. This framework includes measures that would address the general management of fisheries resources in the Sulawesi Sea and specific IUU fishing issues in the area. Such measures include data sharing, sustainable utilisation of shared resources in the Sulawesi Sea, formulation of common and compatible management objectives for the area, MCS-related measures, and cooperation and coordination of measures to address IUU fishing. The workshop was attended by more than 40 participants from both countries, representing the government, industry, and non-government organisations, as well as observers from China.

The second area of progress during the reporting period relates to the editing of written papers for publication purposes. The papers prepared for the national workshops held in 2004–2005 are currently being edited for publication. These papers include a review of international obligations of Indonesia and the Philippines in addressing IUU fishing, profiles of fisheries in Indonesia and the Philippines, adequacy of national fisheries laws and regulations, MCS, fisheries data and collection, fishing vessel registration and licensing, and IUU fishing issues in the Sulawesi Sea.

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

Overseas Collaborating Countries	Indonesia, Philippines, Thailand, Vietnam
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Agency for Food and Fibre Sciences - Fisheries and Aquaculture, Australia
Project Leader	Dr Mike Rimmer Phone: 07 4035 0109 Fax: 07 4035 6703 Email: Mike.Rimmer@dpi.qld.gov.au
Collaborating Institutions	Southeast Asian Fisheries Development Centre, Philippines Central Research Institute for Aquaculture, Indonesia Research Institute for Aquaculture No. 1, Vietnam Network of Aquaculture Centres in Asia Pacific, Thailand Sam Ratulangi University, Indonesia Research Institute for Coastal Aquaculture, Indonesia Gondol Research Institute for Mariculture, Indonesia CSIRO Marine Research, Australia Directorate General Aquaculture, Indonesia
Project Budget	$887,704
Project Duration	01/07/2004 to 31/12/2008 (Project extended from 01/01/2008 to 31/12/2008)
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

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

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

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

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

Project progress

Year 2 (01/07/2005–30/06/2006)

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

Mr Ketut Suwirya (GRIM Bali) visited Northern Fisheries Centre, Cairns, in February 2006 for training in larval enzyme analysis techniques. A follow-up visit was made by DPI&F staff to GRIM in April 2006 to continue the development of larval enzyme analyses using material supplied by GRIM and to initiative collaborative experiments:

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

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

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

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

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

FIS/2003/033: Integrated fisheries resource management (Rinconada Lakes, Philippines and NSW Australia)

Overseas Collaborating Countries	Philippines
Commissioned Organisation	NSW Department of Primary Industries, Cronulla Fisheries Centre, Australia
Project Leader	Dr Philip Gibbs Phone: 02 9527 8411 Fax: 02 9527 8576 Email: philip.gibbs@fisheries.nsw.gov.au
Collaborating Institutions	Bureau of Fisheries and Aquatic Resources, Philippines Econcern Pty Ltd, Australia
Project Budget	$484,242
Project Duration	01/07/2006 to 30/06/2009
ACIAR Research Program Manager	Mr Barney Smith

Project background and objectives

World Bank economic studies of the Bicol River basin have identified the Rinconada System (Lakes Buhi, Bato & Baao-Bula) as ranking second in terms of the incidence of poverty in the Philippines. People in the surrounding communities rely on the lakes for employment, food or navigation access. Management of the system is a compromise between necessary fisheries production through wild harvest and aquaculture and other primary uses of the lakes such as irrigation and hydro-electric power generation versus conservation/sustainability objectives. Overfishing of wild fish stocks, and the increase in cage-based fish farming (tilapia), together with siltation caused by poor land-use practices in the catchment area, have caused serious habitat deterioration (evident from eutrophication (algal bloom), reductions in fish catches, lower growth of fish in cages, fish kills and massive colonisation of lakes by water hyacinth) and a significant decline in fisheries production. .

A management plan has been initiated in Lake Buhi and a draft plan formulated for Lake Bato, but local stakeholders show little inclination to adhere to the plans. Municipal officers are insufficiently equipped to enforce national regulations (and in many cases do not understand the issues). Other stakeholders, including fish farmers and fishers, have a poor understanding of the issues and there is little effective compliance or incentive to change practices.

Project objectives are to facilitate adoption by key stakeholders of actions to improve management of the Rinconada Lakes, together with selected fisheries resources in NSW, Australia. The project will seek to improve fish cage management, increase economic return and reduce impacts on water quality. It will effectively manage water hyacinth infestations in the Rinconada system by physical removal, and document and package the ecosystem-based management findings and outcomes ready for adoption.

Project progress

First progress report due in 2007.

HORT/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	$991,912
Project Duration	01/07/2002 to 30/06/2007 (Project extended from 01/01/2006 to 30/06/2007)
ACIAR Research Program Manager	Mr Les Baxter

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% 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 barriers to pathogen invasion, and may be constitutive (preformed) or inducible in nature. The chemical defences, involving preformed or induced chemicals, cause infections to remain localised and quiescent (with colonisation 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 (for example the avocado cultivar Hass) 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 4 (01/07/2005–30/06/2006)

Objective 1. Host defence mechanisms in mango fruit (Sri Lanka, the Philippines and Australia).

Field trials to evaluate the efficacy of defence activators for postharvest disease control in mango were conducted in Australia (North and South Queensland) and the Philippines. In the Philippines trials were conducted on 'Carabao' mango at two field sites (Site 1: Davao del Sur, relatively dry mango production area and, Site 2: Davao del Norte, relatively wet mango production area), BionR significantly reduced postharvest anthracnose, blossom blight and scab at site 2. Scab was also reduced by BionR at site 1. KasilR and rice hull ash (a mulch containing over 60% silica) reduced anthracnose and blossom blight under certain conditions at site 2. Follow-up trials are planned for the next mango season.

HORT/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 Agriculture and Food, Western Australia, Australia
Project Budget	$549,476
Project Duration	01/01/2001 to 31/12/2006 (Project extended from 01/01/2004 to 31/12/2006)
ACIAR Research Program Manager	Mr Les Baxter

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 5 (01/01/2005–31/12/2005)

Rehabilitation of existing aged and/or damaged bamboo stands for shoots and timber
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 investigating the rehabilitation of natural stands of *Bambusa blumeana*, while the experiment in Impalutao focus on the rehabilitation of a *Dendrocalamus asper* plantation established in 1986. 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.

The experiment at Impalutao, Impasugong, Bukidnon consists of 10 treatments with three replicates. Harvesting of culms was done before the onset of the rainy season. All culms marked to be cut were harvested and measured. No clear trend regarding shoot production was observed. However, based on the data gathered for this year, production of shoots increased, with an average shoot production per clump of 7.37 as compared to last year's average shoot production per clump of only 3.8.

Data from this trial have been used by Mr Graham Cox, a businessman with connections to potential bamboo markets, to assist in the development of a cost:benefit analysis of a proposed giant bamboo plantation to be established on the foothills of Mt Kitanglad in Mindanao.

Maintenance of high productivity of existing plantations for shoots and timber
In 2001 experiments were established in minimally managed plantations in the Philippines at Mariano Marcos State University (MMSU), Batac, Ilocos Norte and at Dumarao, Capiz, Iloilo. The 2005 shoot season is the fifth for these sites. Based on results and problems encountered in the past years the activities in Ilocos Norte activities in 2005 focused on the evaluation of the effects of silvicultural treatments on the basic pole and culm properties for the manufacture of engineered bamboo products. This activity is in response to the recommendation that the study should concentrate on pole production.

The ACIAR-funded bamboo project evaluation of quality of the poles for the manufacture of engineered bamboo products was in collaboration with the project of MMSU and the Department of Science and Technology (DOST) on the pilot commercial production of bamboo tiles and laminates. Considering the requirements of the bamboo tile industry the ACIAR project focused its experiments and observations on the minimum requirements for culm quality. The height and diameter of poles, and culm thickness of the harvested 4-year-old poles, were recorded and analysed to determne the effects of irrigation, fertiliser application and density/spacing.

The density of 4-4-4 (refers to the number of culms/year retained in the clump for the first three years) and lesser number of poles per clump such as 3-3 , and 3-3-3 poles per clump treatment produced poles that met the 1.5 cm culm thickness requirement. In order to optimise production of tiles the 4-4-4 spacing is recommended—more poles can be harvested compared to the 3-3 , and 3-3-3 poles per clump. The costs of inputs for the maintenance of the clumps and harvesting of poles were recorded to determine added cost to produce the desired quality of poles for specific products. The results indicate that to attain the desired quality of poles requires fertiliser application and proper control of density.

At Dumarao 12 treatments were applied to 3-year-old *Bambusa blumeana*. Then starting January 2005 experimental clumps under Treatment 12 were subjected to harvesting so as not to waste the culms produced by these clumps. As such, it was agreed that all 3-year old culms and older would be cut/harvested. With this, Treatment 12 and Treatment 9 had been basically the same. This harvesting will alter the production/yield data, reducing significantly the big disparity in the number of culms among the experimental clumps.

Shoot production was also monitored in the Dumarao experimental site. Data gathering on shoot production was regularly done to monitor the trends on their seasonality. This was later correlated to the availability of water (soil moisture regime), which was previously theorised as the limiting factor to shoot production. Shoot production in Dumarao for the year 2005 averaged 4.72 per clump, with the highest average produced by experimental clumps subjected under Treatments 7 at 7.0 shoots per clump, while the lowest average was Treatment 4 at 1.83 shoots per clump. Experimental clumps under treatment 1 (Control) showed consistently high shoot production (at 6.17 per clump) among other treatments.

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 applications (e.g. furniture, panel boards etc.). A large difference in RD value between blocks per treatment was also observed. The poles which were dislodged/broken/damaged exhibited abnormally lower RD.

The ranges of culm diameter of the bamboo poles collected and used in the study at 1, 2 and 3 years ranged from 39 to 90 mm, 32 to-82 mm, and 41 to 90 mm respectively, while culm wall thickness from 15 to 74 mm, 17 to 66 mm and 16 to 71 mm.

The most number of culms and new shoots emerged from treatments 9 (keep all culms but harvest all 3 years old, continues irrigation with mulch, organic matter and fertiliser) and 10 (4-4-4 culms, continues irrigation with mulch, organic matter and fertiliser). The data will be discussed with Dr. Stanley Malab before conducting the correlation analysis between the number of culms and new shoots, and basic properties.

Survey on the economics of growing and processing of bamboo
The data generated from the market vendors as key informants for the bamboo shoot in the different selected wet markets in regions 1, 6 and 10 were tabulated and analysed. As well the primary data gathered from the key informants in eight industries visited for the engineered bamboo products were tabulated and summarised. These industries include Jireh Industries, FormaPly Industries Inc., Trayline Corporation, Balbin's Quality Furniture, Asia Rattan, Kabagay Handicraft, Bamboo International and CM Bamboo Craft. These are located in Bukidnon, Quezon City, Rizal, Abra, Pampanga, La Union and Iloilo, respectively.

Some of the products produced at MMSU workshop in collaboration with Dr. Malab's project are trays (sold at P500 for a set of 4), coasters (big—3 pcs for P100, small—5 pcs for P100), tiles at P500/sq m, trophies at P400–450/pc, Plaques at P300–P350/pc and rostrums at P5000–5500/pc.

Accordingly, the demand for the engineered products has grown through time. In fact, there had been orders from the Management Association of the Philippines (MAP) to supply the needs of the Pag-ibig housing units for construction. Even the representatives from Megaworld Condo Builders have asked Dr. Malab's group on when was the earliest time they can provide the engineered bamboo requirements for some 200 condo units for construction by the company. However, there is a limited capacity of the existing machine drier at the MMSU.

Dr. Malab's team had supplied the project team with information for the computation of the financial and market potentials of engineered bamboo as required in the ACIAR study. He has agreed to give the other necessary information as soon as his team has come up with the estimates.

The information needed for the final analysis is about 85 % complete. What is lacking are some of the economic information from the bamboo production activities as pursued in the different trial sites in Regions 1, 6 and 10. As soon as these have been retrieved from the project leaders from the said regions, final tabulation and analysis will be done to draw the conclusions and recommended actions that need to be taken.

HORT/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, Philippines Bureau of Plant Industry, Philippines
Project Budget	$505,169
Project Duration	01/01/2002 to 30/06/2006 (Project extended from 01/07/2006 to 30/06/2009)
ACIAR Research Program Manager	Mr Les Baxter

Project background and objectives

Papaya is the fourth most important crop in the world production of tropical fruits, with 5 to 6 million tonnes being produced per year. The most serious disease that threatens the world production of papaya is 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 death of the whole papaya industry in some of its 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% 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 plants produced by this project will be the result of traditional plant breeding systems.

The main aim of this project is to develop stable and fertile backcross lines of papaya that are resistant to the papaya ringspot virus form P (PRSV-P) and could be used as genetic stocks for papaya improvement. It also aims to produce elite genotypes of papaya for Australia and the Philippines which are resistant to PRSV-P, to trial these on growers' properties and to enable the transfer of associated technology to the Philippines.

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 4 (01/01/2005-31/12/2005)

Philippines

During the three years of implementation of the project, we have reported one genotype, BC1 5648 x 410 that showed putative resistance to PRSV-P after three manual inoculations and under field condition for less than two years before it succumbed to bacterial crown rot. Backcrossing activities using the pollen from this plant were intensified during the last phase of the project.

The team generated 137 BC2 03R lines and inoculated them for screening against PRSV-P. After three manual inoculations in a screenhouse, 32 plants (21 female and 11 male) were symptom-free and were transplanted to the field where susceptible papaya varieties are currently being grown. Mild PRSV symptoms were observed a month later. These observed mild symptoms were confined to the older leaves and did not progress to the younger leaves. Symptoms were localised. An ELISA test gave negative results in 21 plants despite the mild and confined symptoms in the older leaves.

Sib-pollination of selected (male and female) BC2 03R line plants are currently in progress towards the advancement of a backcross generation. Likewise, efforts to incorporate and cross the resistant BC2 03R lines to Davao Solo are also in progress. The BC2 03R lines are also being crossed to inbred line 4172 (the male parent of hybrid 'Sinta') to reconstitute 'Sinta' and test the resulting hybrid with 'Sinta' in terms of PRSV resistance. 'Sinta' is tolerant to PRSV-P and is a cross between inbred line 5648 x 4172. This putative resistant PRSV-P BC plant is the first conventionally bred resistant line in the Philippines.

Australia

A fertile PRSV-P resistant plant (line 54) was produced in a previous project when a *C. papaya x C. quercifolia* hybrid was backcrossed to *C. papaya* clone 2.001. All second backcross (BC2) plants produced from line 54 eventually succumbed to PRSV-P after 9 months in the field. However, there was large variation between plants in terms of degrees of severity to the virus symptoms and time to develop symptoms (2 to 9 months). Thus line 54 had a high level of tolerance to PRSV-P but was not resistant. BC2 plants showed good agronomic traits: high yields, good fruit shape, flavour and high brix levels. These results show that commercially acceptable fruit could be produced after 2 or 4 backcrosses.

Five F1 plants (*C. papaya* x *V. quercifolia*) that were PRSV resistant and had low pollen fertility were used to produce 131 BC1 plants. All were cloned and multiples of each clone were field tested in the presence of PRSV-P. All developed viral symptoms, however symptom severity and time to infection varied between clones.

A BC2 population developed from the resistant BC1 plant produced in Los Baños has been field tested against an Australian strain of PRSV-P in SE Queensland. After 6 months in the field, 100 plants are segregating for PRSV-P resistance.

V. pubescens and *V. parviflora* and an F1 and F2 population derived from them were used as a mapping population. The F2 segregated in a 3:1:resistant: susceptible ratio indicating a single dominant gene controlling PRSV-P resistance in Vasconcellea. A genetic map of the two species has been developed using RAF markers. Twelve 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. The other segregates 100% with PRSV-P resistance, and is being used to identify the PRSV-P resistance gene.

Clones of all *C. papaya* genotypes, *Vasconcellea* species, fertile resistant *C. papaya* x *V. quercifolia* hybrids, and some backcross plants (including 54) are being maintained in vitro. This collection is essential for future research.

HORT/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: 07 38969677 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 Bureau of Plant Industry, Philippines
Project Budget	$1,012,092
Project Duration	01/01/2005 to 30/06/2008
ACIAR Research Program Manager	Mr Les Baxter

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 and 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)

Objective 1: To develop improved recommendations for integrated pest management and judicious pesticide use.

Objective 2: To improve control and detection of seed and pulp weevils.

Objective 3: To identify and trial improvements to current practices and conditions for managing mango supply chains.

Integrated Pest Management
In Australia, nine orchard sites producing the main commercial varieties 'Kensington Pride' and 'R2E2', near Bowen and near Mareeba have been surveyed fortnightly, finding some high fruit spotting bug populations actively feeding on emerging flower panicles at two locations. Fruit spotting bug is reducing yield because of damage to flowers and by causing premature fruit drop and quality reduction by damaging fruit. It is believed that feeding damage caused by fruit spotting bug establishes entry points for the development of anthracnose and the combination of these two factors is a major contributor to the problem. A DPI&F facility to detect and analyse pheromones is currently being established within other projects. This will be used for the major mango pests when operational.

In the Philippines the project team has set up experimental sites on commercial farms. Two farms in each of the provinces of Guimaras, Davao del Norte and Davao del Sur have been chosen as areas for the IPM and supply chain improvement project. Mangoes grown in Guimaras are exported to the US while fruit from Mindanao are sent to Hong Kong and Japan as well as to Manila. In Mindanao the trial sites take in the two distinct climatic conditions encountered in the Davao region.

A survey to obtain initial baseline data on farmer production management practices has commenced in Guimaras, involving both well-managed orchards and backyard-type mango production. The survey is collecting information on farmers' practice and proposed management intervention at pre-bearing stage. Data are also being obtained on yield and production cost.

The project team also conducted a workshop to familiarise the field staff in Guimaras and Davao with project design and strategies, proposed intervention, commitments/roles and responsibilities, use of pest monitoring sheets, and coordination mechanisms established for the project. Although pest monitoring has now commenced, it has been found that those doing the monitoring do not have adequate resources to perform the task effectively. Discussions are under way to develop a pest monitoring kit to improve effectiveness of those involved in monitoring.

Mango pulp weevil and seed weevil
Planning is complete and field trials have commenced on Palawan on pulp weevil biology and control strategies using chemical and particle films. A complementary project on mango seed weevil and pulp weevil under the AusAID Asia Public Sector Linkages Program (PSLP) is currently running. Mango seed weevil, which has been considered a minor pest of Australian mangoes, has over the last year become a significant pest, as its presence is now having a substantial detrimental effect on mango export opportunities to China, UAE, Malaysia and South Korea. This project will contribute to a suite of new projects to investigate the problem, which will commence in the coming season.

Supply Chain Improvement
In the Philippines, fruit damage caused by poor packaging and handling practices has been identified as major causes of quality loss. Changing practices will require some parts of the industry to adopt significant changes. Strategies to facilitate this are being developed. In Australia, the mango industry is undertaking a major review of its export strategy. When this is complete in mid-2006, the export supply chain work within this project will commence.

HORT/2006/006: Development of an embryo culture manual and an embryo transplantation technique for coconut germplasm movement and seedling production of elite coconut types

Overseas Collaborating Countries	Philippines
Commissioned Organisation	University of Queensland, Australia
Project Leader	Dr Steve Adkins Phone: 07 33652072 Fax: 07 33651177 Email: s.adkins@uq.edu.au
Collaborating Institutions	Philippine Coconut Authority, Albay Research Center, Philippines
Project Budget	$67,800
Project Duration	01/01/2006 to 30/06/2007
ACIAR Research Program Manager	Mr Les Baxter

Project background and objectives

World coconut (*Cocos nucifera* L.) productivity has been low for decades and nearly 2/3 of the existing palms are becoming too old for sustained production. Coconut farmers, mostly low-income smallholders, in more than 90 countries need high-yielding varieties which suit their local conditions. A systematic replanting program requires a good breeding program that relies on the availability of new germplasm. The collection and movement of coconut germplasm must be undertaken using embryo culture technique because transporting the whole fruit is impractical and phytosanitary-unsafe. A new protocol of embryo culture has been developed from an earlier ACIAR-funded project (HORT/1998/061) involving some of the coconut producing countries in South East Asia, including the Philippines. The new protocol is more efficient in producing robust plantlets, which are easily planted in soil to give a high percentage of plant establishment. Such a new protocol will also be applicable to the production of seedlings of elite coconut types such as Makapuno and aromatic, which have a high economic value. The details of this new embryo culture protocol need to be shared with other potential users beyond the present team, and therefore the production of a manual is necessary. A proof-read, protocol manuscript will be produced in three languages (English, Indonesian and Vietnamese) and published and distributed through ACIAR.

Project progress

First progress report due in 2007.

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
Project Web Site	http://www.clw.csiro.au/research/urban/reuse/ ; http://www.clw.csiro.au/research/water/groundwater/
Collaborating Institutions	Bureau of Soils and Water Management, Philippines
Project Budget	$399,788
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 rainfall reduction 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 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 2 (01/07/2005–30/06/2006)

Work on groundwater management within the Philippines has focused on two pilot sites within neighbouring municipalities of the province of Ilocos Norte, namely Burgos and Pasuquin, located on the north-western tip of Luzon. For Year 2, activities within these two sites focused on characterisation of the groundwater resource, and collection of data necessary to determine sustainable yield and to set up a groundwater model. The groundwater model will enable future impacts of groundwater extraction to be determined, as well as impacts of changed management. Pumping tests have been conducted to determine aquifer transmissivities, and pressure loggers have been installed in a number of wells to record fluctuations of water levels.

An economic assessment of agricultural productivity within the two field sites is complete. Rice and garlic are the two main crops, with rice grown during the wet season, and garlic supplemented by groundwater grown during the dry season. Labour and fertiliser costs are the largest input costs for both rice and garlic production, although the cost of fuel for pumps is significant for garlic. Growing one hectare of garlic generates a total return of three to four times that of rice. In terms of gross margin, garlic provides a return five to six times greater than rice. Rice, however, remains a traditional crop for two reasons: it provides a staple food for household consumption, and it provides rice straw as mulching material for garlic.

Prior to the formulation and implementation of water use strategies, a two-day farmers' training was conducted in Barangay Susugaen, Pasuquin, Ilocos Norte on May 4-5, 2006. Attended by 26 farmers and 19 agricultural technicians from the study sites, lectures on water-saving technologies (i.e., alternate wetting and drying or AWD for rice production and the use of aerobic rice) were presented. Field practicum on the installation of piezometers for monitoring available water in the field formed part of the training. Aerobic rice seeds (at 2 kilos per participant) were distributed to enable participants to reproduce seeds for bigger areas.

A three-day workshop on Groundwater Modelling was conducted in Manila on June 8-10. The first day was attended by 26 staff from BSWM and other agencies involved with water management in the Philippines. The second day involved hands-on demonstration of computer modelling, and involved eight staff working on four computers. The workshop discussed the principles of groundwater modelling, and demonstrated the practical aspects of modelling with the MODFLOW software.

Work on groundwater modelling of the Burgos site is now in progress. When complete the model will allow the hydrological impacts of a range of changed land and water management scenarios to be evaluated. Economic analyses of different management scenarios will also be conducted.

Work is also under way within Australia, to design artificial recharge systems for use in sandy aquifers that predominate in lowland areas of the Philippines. An evaluation of the performance of roughing filters in removal of colloidal kaolin as a pre-treatment for biofiltration (slow sand filtration) was completed. A review of biofiltration is nearing completion and a testing facility has been established adjacent the Urrbrae Agricultural High School wetland to enable evaluation of biofiltration design variables. Studies are in preparation to characterise labile nutrients in stormwater as a predictor of biofilm growth and clogging in injection wells. This will be used to design a water sampling and evaluation program in Ilocos Norte. A review of well completion techniques enabled design of wells for construction at the Urrbrae site for an ASR pilot study. Unfortunately the thin alluvial aquifer was not encountered in either well and it is proposed that a deeper well be installed once water quality testing has established that biofiltration is likely to be effective for an ASR trial. This would give confidence before application in Ilocos Norte.

LWR/2004/069: Minimising agricultural pollution to enhance water quality in Laguna de Bay (Philippines) and Mt Lofty Ranges (Australia)

Overseas Collaborating Countries	Philippines
Commissioned Organisation	CSIRO Land and Water, Waste and Contaminant Risk Assessment, Australia
Project Leader	Dr Rai Kookana Phone: 08 8303 8450 Fax: 08 8303 8565 Email: Rai.Kookana@csiro.au
Project Web Site	http://www.clw.csiro.au/cecr/ ; www.clw.csiro.au/staff/KookanaR/
Collaborating Institutions	University of the Philippines at Los Banõs, Philippines Laguna Lake Development Authority, Philippines
Project Budget	$657,501
Project Duration	01/05/2006 to 30/04/2009
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Laguna de Bay is the Philippines' largest and most important freshwater resource, being made up of three bays that form one lake. The eastern of these bays is intended to provide Metro Manila with water in the near future. Heavy wastewater discharge and runoff cause pollution in the western bay. The eastern bay's main water source is the Pagsanjan River, a part of the Pagsanjan-Lumban sub-catchment, most of which is used for agriculture and is increasingly a source of nutrient and pesticide pollutants. Identifying and quantifying these pollutant sources will be undertaken as part of a comprehensive biophysical and hydrological characterisation of the sub-catchment. Complementary activities will be undertaken in the Mt Lofty Ranges in Australia.

Project progress

First progress report due in 2007.

PLIA/2005/151: Philippine policy linkage scoping study

Overseas Collaborating Countries	Philippines
Commissioned Organisation	Centre for International Economics, Australia
Project Leader	Dr Sandy Cuthbertson Phone: 02 6245 7800, Mob: 0418 486 698 Fax: 02 6245 7888 Email: scuthbertson@thecie.com.au
Collaborating Institutions	SEAMEO Regional Centre for Graduate Study and Research in Agriculture, Philippines
Project Budget	$77,400
Project Duration	16/06/2006 to 15/03/2007
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

This is a scoping study which will review the economic and policy environment in the Philippines, especially for the agriculture, forestry and fisheries sectors. It will assess the importance of this environment as a constraint to the adoption of ACIAR-funded project outcomes. A workshop will be held in the Philippines to consider the findings and determine whether there are follow-up projects on some of these issues which could achieve some changes in the environment and thus improve the likelihood of future adoption. If appropriate it will develop a project proposal for the follow-up activities.

Project progress

First progress report due in 2007.

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	$651,190
Project Duration	01/01/2001 to 30/09/2006 (Project extended from 01/07/2006 to 30/09/2006)
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 5 (01/01/2005–31/12/2005)

All of the planned objectives for this extension period have been achieved with few exceptions.

The major focus of the extension was in the Philippines, where practical farm-based biofumigation technologies were evaluated, developed and tested. The approach was to focus on potato production systems in Benguet and Mindanao and combine farmer surveys and an Industry workshop, with replicated experiments on research farms and participatory on-farm research and extension. Two phases of experiments supported by laboratory studies were completed (Phase 2 still being finalised at time of writing). The results from replicated experiments support previous observations regarding significant suppression of bacterial wilt using biofumigation (50–80%), and associated increases in yield although variability in the response remains an issue.

A mid-year industry workshop was attended by 40 advisors, growers and farm trainers including FAO staff from Thailand, Cambodia, Laos, Vietnam and Indonesia where opportunities and constraints to adoption of biofumigation were discussed. On-farm participatory experiments and farmer field schools have been carried out at two sites in Mindanao, and in Benguet, and in some cases the farmers have already integrated biofumigation principles into their vegetable production systems. A Biofumigation Manual is being prepared on the basis of work on the project, and an FAO booklet has already been compiled and distributed which contains many outcomes from this project. An engineer based at UPLB has completed two preliminary student projects on identifying and modifying small-scale incorporation equipment suitable for Filipino farmers and a machine is now in the process of modification and testing. Dr Kirkegaard visited the group from 23 to 27 January 2006 and the project is on track to achieve the milestones as planned.

Supporting experiments at NCPC during this phase have demonstrated the importance of soil type on the effectiveness of biofumigation (less effective on heavier textured soils), demonstrated that significant suppression can be achieved without complete tissue maceration, demonstrated that 10% ethanol added during the preparation of “brews” increases their effectiveness (unrelated to direct effects of ethanol), and that organic matter additions do increase the population of antagonistic organisms, particularly on heavy textured soils. These experiments have all provided important insights to assist in design of practical approaches to biofumigation.

In Australia the focus was on laboratory (CSIRO Canberra) and field studies (QDPI Mareeba) to evaluate the relative contribution of ITCs and organic matter to the suppressive capacity of brassicas. Isolines of mustard with varying concentrations of ITC were used in the studies and these were compared with non-brassica tissues and synthetic fumigants. The Canberra studies confirmed a rapid impact (days) of brassicas related to ITCs and a slower suppression (weeks) associated with organic matter addition. The rapid ITC effect was shown to be highly dependent on soil type with much more effective suppression on light textured soils with lower organic matter. We demonstrated that the poorer effect of biofumigation observed at Endeavour farm in 2004 compared to the excellent results at Southedge in 2003 (and 2005), may have been partly due to these soils differences.

The Southedge experiment in 2005 has demonstrated that a mustard high in ITC was more effective in reducing bacterial wilt (9.8% infection) and increasing yield (55 kg/plot) than mustard with no GSL (33% infection, 28 kg/plot), clearly demonstrating a role for ITCs in the biofumigation response on this soil. The impacts of soybean and weedy fallow were similar to the low ITC mustard. Interestingly the synthetic fumigant (metham sodium) provided a level of control similar to the low GSL mustard and other green manures. The observations support the hypothesis that both a short-term ITC effect and an organic matter effect operate in disease suppression, and both of these effects are combined in a high GSL green manure. These data support the 2003 Southedge experiment in which most of the green manures provided some level of suppression, but the high GSL mustards provided the most effective control. The lighter textured soil at the site also contributes to the effectiveness of biofumigation at the site. In Australia the focus now will be on compiling and publishing the results of the project and finalising the cost/benefit analysis now that a second year of yield data have confirmed the level of suppression which is achievable.

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	Dr Paul Fox

Project background and objectives

Stagnating productivity of irrigated rice (*Oryza sativa*) in the Philippines 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 3 (01/07/2005–30/06/2006)

Objective 1: Fertilisation-independent (FI) formation of rice endosperm and pericarp

Refined FI pericarp formation based on understanding of OsAsp1 function (I)
Both IRRI and CSIRO have engineered methods for by passing the fertilization-dependence of pericarp and seed coat enlargement. This by pass is essential for achieving independent seed production, because it removes a physical constraint on the size of the endosperm that can develop autonomously.

Refined FI endosperm formation based on RNAI of OsFIS genes (C)
FI endosperm formation in rice is essential for constructing a form of apomixis in which the escape of transgenic pollen is prevented. CSIRO has a method of generating fertilisation-independent formation of the endosperm in *Arabidopsis*, based on the discovery through mutation of three Fertilization-Independent Seed (FIS) genes. This method has been introduced into rice. Based on sequence similarity, all the FIS like genes in rice had been identified, and transgenic lines with silencing constructs for each OsFIS gene are being evaluated.

Objective 2: FI embryogenesis in rice nucellus

Isolated rice orthologue of maize MAC1 gene (I)
We are focusing on developing a synthetic form of apospory for rice. Aposporous embryos develop from nucellar cells near the megaspore mother cell (MMC). The maize mutation multiple archaesporial cells1 (mac1) showed that such nucellar neighbours can develop into secondary MMCs if the MAC1 gene is inactivated. One of IRRI's objectives was to clone the rice orthologue, OsMAC1. However, this task was actually accomplished by Nonomura et al.(2003) in Japan [Plant Cell. 15:1728-1739], and they named the rice gene MULTIPLE SPOROCYTES1 (MSP1).

A key paper on the genetics of the control of apomixis and sexuality in *Poa pratensis* was published by Matzk et al. (2005) Plant Cell 17:13–]24.

Isolated rice orthologues of Arabidopsis CLV, WUS, STM and AG genes (C & I)
Embryogenesis in the rice nucellus will probably require re-activation of meristematic activity through expression of orthologues of such Arabidopsis genes as CLAVATA1-3, WUSCHEL, SHOOT MERISTEMLESS and AGAMOUS. IRRI and CSIRO identified orthologues by sequence comparisons. In the last year, Mr. Rico Gamuyao of IRRI examined 10 members of the rice WOX gene family to ascertain their expression patterns, using reverse transcriptionpolymerase chain reaction (RT-PCR) and RNA in situ hybridization. He found that two genes were highly expressed in the ovule.

System to control genes of nucellus from megaspore mother cell (MMC1) (I)
Leucine-rich receptor kinases like MSP1 are usually triggered by the binding of extracellular 4 ligands to the LRR domain. We are attempting to identify the ligand of MSP1 and its site of synthesis. We are guided in this search by the finding that a LRR receptor kinase is implicated in the control of tapetum development by pollen mother cells, PMC, in *Arabidopsis*.

OsMac1 based system for inducing secondary MMC (MMC2) (I)
In the homozygous msp1 mutant, up to 15 secondary MMCs are induced in each ovule. IRRI is now attempting to interfere with the function of MSP1 more subtly to induce only 1-2 secondary MMCs which will then be induced to form aposporous initials through the bypassing of meiosis.

Objective 4: Communication and dissemination of research results

Publications and website for pre-publication releases (10/-03)
Publication
Bi X, Khush GS, Bennett J. 2005. The rice nucellin gene ortholog OsAsp1 encodes an active aspartic protease without a plant-specific insert and is strongly expressed in early embryo. Plant Cell Physiol. 46:87-98.

Website
A website for the project is being constructed. It will contain information on Phase 1 and Phase 2, including publications and reports.

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

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

Project background and objectives

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

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

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

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

Project progress

Year 2 (1/1/2005–31/12/2005)

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

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

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

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

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

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

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

Concluded projects

1 July 2005 to 30 June 2006

Bilateral

Multilateral

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, Division of Veterinary and Biomedical Sciences, Australia
Project Leader	Dr Simon Reid Phone: 08 9360 7423 Fax: 08 9310 4144 Email: s.reid@murdoch.edu.au
Collaborating Institutions	Research Institute for Veterinary Science, Indonesia Dinas Peternakan, Irian Jaya, Indonesia National Agriculture Quarantine and Inspection Authority, 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	$600,002
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.

Before any control programs could be designed, more knowledge was needed about the impact of *T. evansi* on livestock and the determinants of clinical disease. This would require sensitive and well-validated diagnostics tests, coupled with an understanding of the genetics of virulence in the different strains of *T. evansi*. To date there were no such effective tests, and drugs used in treatment had not been systematically evaluated.

Both Indonesia and the Philippines wanted to establish control mechanisms to reduce livestock infection and improve productivity. This project therefore involved both countries, along with Papua New Guinea and Australia, building on earlier research into the parasite carried out at James Cook University, Townsville (ACIAR project AS1/1996/150) that demonstrated the inadequacy of existing diagnostic tests.

The project aimed to develop accurate diagnostic tests for this parasitic disease, to establish more effective ways of controlling it, and to transfer this technology to neighbouring countries to improve surveillance and reduce the risk of disease entry to Australia.

Project outcomes

The project's main scientific achievement is a considerably enhanced capability for effective surveillance of Surra in Irian Jaya, PNG and the Philippines. A network of researchers on *T. evansi* from Indonesia, the Philippines, Australia, PNG and external agencies such as ILRI is now firmly established.

The successful outcomes were achieved by the transfer of current diagnostic technologies which were then improved by identifying more specific and sensitive tests for serological diagnosis. The scientists developed molecular techniques for low-level detection of organisms in blood samples, identified genetic markers for pathogenicity of *T. evansi* and tested their usefulness in predicting outbreaks of clinical disease. They also investigated the efficacy of existing trypanocidal drugs for the treatment of *T. evansi*. The elucidation of the epidemiology of infection with *T. evansi* in Mindanao and Sulawesi was a significant and important contribution to understanding the disease in Asia. A secondary, vital achievement was development of techniques to collect and send blood and tissue samples to Australia in compliance with Australian quarantine standards.

The research to date suggests there are multiple factors involved in the development of outbreaks of Surra in the Philippines. The severity of outbreaks of Surra in Mindanao could be due in part to genetic differences compared to Indonesian isolates, and preliminary results using the mouse pathogenicity test suggest this. Pathogenic strains of T*. evansi* were identified in specific areas, indicating that control programs must focus on regions where acute clinical disease is most likely and that the response to notifications of clinical disease must be rapid to prevent death due to infection.

Further technology transfers to participating countries should improve the effectiveness of surveillance for *T. evansi*. The information gathered can then be incorporated into guidelines on the most cost-effective treatments of infection with *T. evansi*. This should improve the success of treatment and control programs based on treatment of infected animals.

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	Ms Christie Chang Phone: 02 6773 2855 Fax: 02 6773 3596 Email: hchang@metz.une.edu.au
Collaborating Institutions	University of the Philippines at Los Baños, 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% 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 outcomes

The research objective was met with four milestone activities through collection and analysis of farm survey data, personal interviews of market informants and government officials, and reviewing existing literature and secondary data. They include:

- Overview of the Philippine poultry industry
- Analysis of Philippine poultry production
- Analysis of Philippine poultry marketing
- Comparative analysis.

Outputs

Main outputs from this research project include: two technical reports, six working papers, three conference papers, and five manuscripts that have been, or will be, submitted for journal publications. In addition, there are 13 conference presentations, four undergraduate student theses, one Masters thesis, and more than a dozen of invited speeches and lectures to government and industry bodies, which are all part of the project outreach and training activities. Key outputs from each of the milestone activities are summarised below.

Overview of the Philippine poultry industry produces a technical report that describes the industry structure of all four poultry sub-sectors (broiler chickens, layer chickens, native chickens and ducks), analyses trends in production, consumption, imports, exports and prices of poultry products, and reviews government development and trade policies pertaining to the Philippine poultry industry.

Analysis of the Philippine poultry production produces several conference papers based on surveys of around 500 duck and native chicken farms. These conference papers analyse farming practices and socio-economic characteristics of surveyed farms, identify constraints to smallholder production and marketing, and recommend intervention strategies both at the policy and industry levels.

Analysis of the Philippine poultry marketing produces three conference papers though literature review and interviews with key market informants and government officials. The analyses identify major players in the supply chain and their functions and examine various issues resulting from market imperfections.

Comparative analysis also produces several conference and working papers, which compare the performance of the Philippine poultry industry with the world's best practices as well as the structure and performance between backyard and commercial sectors in the Philippines.

Main conclusions from the research are:

- The demand outlook facing the Philippine commercial poultry sector (broilers and layers) is positive due to production efficiency in industrialised poultry production and the anticipated income and population growth in the country. However, the Philippine poultry industry is still considered inefficient relative to the world's best practices. This means that the commercial sector is facing increasing threat from imports as the world's major poultry producers continue to promote their products through new and improved products and aggressive marketing strategies. To compete, the commercial sector must upgrade production technologies, reduce input costs, and improve marketing efficiency.

- The small backyard poultry sector (ducks and native chickens), relative to the commercial sector (broilers and layers), is facing serious constraints in production and marketing due to market imperfections, which include the lack of market information and technical know-how and the lack of access to credit, extension, and other key inputs. Bio-security concerns, highlighted by recent avian influenza outbreaks worldwide, including many other Asian countries, may impose further constraints on the backyard sector.

- The future of the native chicken sector appears to be uncertain. On the one hand, its products are preferred by consumers for their freshness and unique taste. On the other hand, it is uncompetitive in price and consistency in quality and supply. More resources must be made available to the smallholders before they can remove the constraints in production and take advantage of the favourable demand conditions.

- The duck sector, appears to be profitable particularly for large, commercial operators and the demand for 'balut' and other duck egg products can be expected to grow in the near future along with population and income growth. However, the demand for 'balut' and other duck egg products in the medium to long terms is of some concern due to likely changes in consumption patterns as a result of economic development and urbanisation. More research on demand trends and new product development is needed in order to understand and meet changing market requirements. In addition, official product standards must be established and reliable market information must be provided to correct market failures and improve marketing efficiency.

In addition, the project also identified several areas for future research, such as the impact of increased commercialisation of duck operations on smallholders, the environment, on bio-security. More research on future consumer demand for poultry products such as 'balut' and native chicken, and on new product development, is also deemed necessary to more comprehensively assess the future prospects of the poultry industry. More research is also needed to assess the need for the development of official grading standards and to improve the collection and publication of official statistics.

Impact
In 2004, the Philippine duck sector generated 5.77 billion pesos ($A150 million), which accounted for 0.74 per cent of total gross value of agricultural production. But its contribution to the Philippine economy was not well-known and as such it had received little attention or support from the government. As a result of project dissemination and communication activities, two changes in the industry, particularly the duck sector, are noticeable. First, policymakers in government agencies such as the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Livestock Development Council (LDC-DA) and Bureau of Animal Industry (BAI-DA) are more aware of the importance of the smallholder duck production to the Philippine agriculture and the rural economy, as well as the constraints facing the smallholders. As a result, more government support is now being provided to the duck sector in the form of sponsoring industry forums, training courses, and field days. In addition, the government has supported, and actively involved in, the development of a road map for setting strategic directions for the duck sector. More research funds are also expected to be made available for ducks along the line recommended by the project.

Second, as a result of this project, several duck farmers' organisations, such as the Duck Industry Association of the Philippines (DIAPI) and its provincial counterparts, have been formed to begin addressing, as a group, the concerns of their sector and lobbying for government support. The newly formed duck groups, along with the Philippine Association of Broiler Integrators (PABI), United Broiler Raisers Association (UBRA), Philippine Egg Board, and Federation of Egg Producers of the Philippines, are a key step toward reducing the fragmentation of the Philippine poultry industry and its international competitiveness.

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

Overseas Collaborating Countries	Philippines
Commissioned Organisation	Centre for International Economics, Australia
Project Leader	Dr Sandy Cuthbertson Phone: 02 6245 7800, Mob: 0418 486 698 Fax: 02 6245 7888 Email: scuthbertson@thecie.com.au
Collaborating Institutions	University of the Philippines, Center for Local and Regional Governance, Philippines
Project Budget	$398,275
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 outcomes

The primary outputs promised in the original design of this project are:

- an appreciation of how extension activities happen in the devolved system.
- a description and analysis of other major changes in the environment for extension (besides devolution) in the Philippines
- a framework for identifying niches for delivery of public extension
- exposure of these outputs to Filipino practitioners and policy makers by way of conferences and workshops to be part of the ongoing assessment and debate shaping policies concerning devolution, agriculture and extension.

Appreciation of the impact of devolution

Using a range of information-gathering methods including case studies, Steering Committee meetings, field visits and literature reviews, the project came to the following key findings about the devolution experience.

Continuing concerns about extension delivery are set out below.

- The relative roles of central and local agencies remains unclear.
- Many central agencies continue to be involved in extension resulting in:
  - waste and duplication;
  - extension resources being diverted from local priorities;
  - continued commodity emphasis;
  - maintenance of a tops down supply-driven approach over one that is bottoms up and demand-driven;
- Training of extension officers is piecemeal and limited in terms of planning and other ‘higher order’ skills.
- Some municipalities appeared to be too small to deliver extension services efficiently.
- In those LGUs where the devolved extension service had apparently been ‘successful’ this success was ‘hostage’ to a particular leader and with the fall of that leader programs would be brought to a close no matter how successful.

On the other hand there were positive signs as illustrated below.

- In some LGUs a farm system approach aimed at family incomes had replaced the old commodity driven production targets approach.
- Extension partnerships with private sector, seed suppliers, universities and NGOs were being formed.
- Farmers were less inclined to equate extension with subsidies and co-payments for seed, fertiliser and stock were becoming accepted.
- Some LGUs were cooperating to achieve benefits of size.

Environment for extension

Some of the more significant aspects of this environment for extension delivery include:

- the steady diminution in farm size from 3.7 ha in the 1970s to 1.7 ha in the 1980s to 0.6 ha in 2004.
- security of tenure is weak even in agrarian reform areas and opportunities available from tenant share farming are restricted by law.
- access to the internet in isolated areas is hampered by weak communication infrastructure.

In reviewing these initial findings with the Steering Committee it was agreed that along with most studies of extension in the Philippines this first-round work focused on delivery or supply of extension and that more attention needed to be paid to demand. Consequently case-study writers were asked to revisit their case-study areas to assess factors affecting demand for extension. Some of the main outputs from this follow up work were:

- farmers on small pieces of land had both little capacity and incentive to demand extension services.
- commercial farmers, including those involved in hog and boiler raising, seemed to have good access to commercial extension.
- contract growing among small farmers especially landless and farm workers by way of consolidating their rented lands is emerging. This endeavour provides sustained income to small farmers.

Niches for public extension

Suggested key niches for public extension in the Philippines are:

- moving away from a commodity approach towards a farm system and farm family focus.
- working with low income/small farm communities with a holistic approach to promote development through cooperative farming, diversification to off-farm income and sustainable production.
- focusing on practices relating to pest and disease control, water and waste management where impacts extend beyond the farm and where extension delivery may need to involve delivery from a unit larger than LGU, for example at the provincial level.
- working with larger commercial producers on a copayment basis to develop the further emergence of private sector advisors.
- providing packaged information, demonstrations and training packages targeted towards mass dissemination and access and informing private providers of extension and advisors of best practice.
- providing feedback to research and policy makers in terms of the needs and best directions for rural/agricultural communities.
- importantly the findings stress that input subsidies are not good extension methods.

Dissemination and training

The project design explicitly provides for activities to expedite turning these outputs into outcomes. To this end the project supported and participated in dissemination activities including hands-on workshops in case study areas, presentation of papers at two national conferences and co-sponsorship and keynote paper presentation at a National Summit on Extension (see section 3.1).

Study findings suggest that:

- a systematic approach be taken to training extension workers at LGU level supported by nationally developed workshops and courses.
- key training areas should incorporate: relevant production technologies; project planning, management and evaluation; participative extension approaches—including facilitation skills pertinent to networking with farmers and across stakeholder groups; and holistic approaches to farming community development including cooperative farming, value adding and off-farm income.
- extension should be coordinated at Provincial level to limit political interference and variability of support, to provide better career pathways and to allow the more systematic approach to training.
- attention should be given to understanding competitiveness, farm and family economics, cooperative farming, value adding opportunities or off-farm income—areas which could offer the greatest opportunities for positive development in their client group.

ASEM/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 Daglish Phone: 07 3896 9415 Fax: 07 38969446 Email: Greg.Daglish@dpi.qld.gov.au
Collaborating Institutions	
Project Budget	$61,715
Project Duration	22/06/2005 to 31/12/2005
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

In March 2005, ACIAR began working in partnership with the Bureau of Postharvest Research and Extension (BPRE) in the Philippines. The objective of this partnership was to identify options for follow-up on earlier projects which involved BPRE formerly (NAPHIRE), the Queensland Department of Primary Industries and Fisheries (DPI&F) and other Australian agency partners. This consultancy will involve staff from DPI&F working in collaboration with BPRE and other stakeholders, to identify and address information, knowledge and training gaps and initiate study of postharvest grain systems focussing on smallholders.

Project outcomes

At as October the final report is forthcoming.

CP/1996/091: Biological control of *Chromolaena odorata* in Indonesia, Papua New Guinea and the Philippines

Overseas Collaborating Countries	Indonesia, Papua New Guinea, Philippines
Commissioned Organisation	Queensland Department of Natural Resources and Mines, Australia
Project Leader	Dr Michael Day Phone: 07 3375 0725 Fax: 07 3379 6815 Email: Michael.Day@nrm.qld.gov.au
Collaborating Institutions	Universitas Nusa Cendana, Indonesia SEAMEO Regional Centre for Tropical Biology, Indonesia National Agricultural Research Institute, Papua New Guinea Parks and Wildlife Commission of the Northern Territory, Australia Gadjah Mada University, Indonesia Philippine Coconut Authority, Philippines Indonesian Oil Palm Research Institute, Indonesia Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement, Indonesia Oil Palm Research Association, Papua New Guinea
Project Budget	$1,055,012
Project Duration	01/07/1997 to 30/09/2006 (Project extended from 01/01/2002 to 30/09/2006)
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Siam weed is a serious weed of tropical pastures and a threat to national parks and other biodiversity conservation areas. It is a prolific seed-producer and is usually toxic to livestock. It has quickly spread from its original home in the West Indies to large areas of the wet tropics of Africa and Asia. It reached Timor by the mid-1970s and is now present in parts of Irian Jaya, New Britain and possibly the Solomon Islands.

Siam weed is now considered the major weed threat to Australia. An infestation was discovered in Tully, Queensland, in 1994 and is now being eradicated with herbicides. There are many natural enemies of this weed and biological control has long been touted as an option. By 1992, only two agents had been tried; a seed-eating weevil (*Apion brunneonigrum*) and a leaf-eating moth (*Pareuchaetes pseudoinsulata*), which were both tried in South Africa.

ACIAR project CS2/91/10 released the moth into oil palm and pastoral areas in Java, Sumatra and Timor. The moth successfully established in several areas in Sumatra, where there is now effective control of the weed. However, the agent did not persist in Java or Timor. Project CS2/91/10 also introduced a new control agent, the stem-galling fly *Procecidochares connexa*, from South America, which had not been tried or host-tested anywhere else in the world. The first releases were made in Indonesia in July 1995; it was also intended for release in the Philippines but government permission was not granted during the lifetime of the project. However, permission came through in February 1997, so this agent was released in the current project.

The aim of this project was to enhance the biological control of Siam weed (*Chromolaena odorata*) in Indonesia, Papua New Guinea and the Philippines. The work begun in the previous ACIAR project continues. The current project intends to carry out further releases, conduct field monitoring of their effectiveness and introduce additional control agents.

Project outcomes

In the previous project (1993–97) Indonesia approved the field release of the gall fly *Cecidochares connexa*. In this project the Indonesian government further approved the field release of the butterfly *Actinote anteas*..By this approval the Indonesian authorities showed that they accepted the release of a new agent not been previously released anywhere in the world, **based solely on tests undertaken by their own organisations**.

Value of research and principal beneficiaries

The value of this research is three-fold:

- the achievement of safe, sustainable control of this major weed in Indonesia and PNG, and the prospect of this for the Philippines.
- training for scientists in south-east Asia in biocontrol as a method.
- reduction in the risk of spread to northern Australia.
- a proven biocontrol method for use in other countries with this weed, and in Australia if chromolaena does become established.

The beneficiaries are thus:

- plantations, forestry, small farmers, and cattle husbandry in Indonesia, PNG, and the Philippines. Weed control is one of the major costs of slash-and-burn husbandry, and is economically impossible for cattle production. Chromolaena has caused total abandonment of whole villages dependent on cattle and small-scale crops in areas with a severe dry season. The progressive control achieved through this research will enable the livestock industry in these areas to survive.

- the scientists involved directly, and indirectly the whole of South East Asia. Biocontrol is an environmentally benign and economically sustainable weed control method, which is under-utilized because of lack of knowledge and experience.

- all of northern Australia, through reduced surveillance costs, and reduced costs and environmental damage if/ when the weed becomes established in northern Australia.

- other countries with this weed problem (India, West Africa, Pacific countries) who can import the gall fly for minimal cost.

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	Dr Graeme Hamilton
Collaborating Institutions	
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 outcomes

As at October 2006 the final report is forthcoming.

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

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

Project background and objectives

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

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

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

Project outcomes

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

Auxins (IBA and NAA) (plant hormones) when applied at various times during the early steps of embryo germination will increase root production and this will result in greater *ex vitro* seedling vigour. A simple acclimatisation method, using a wooden box with a transparent plastic sheet lid, will produce better quality seedlings than those produced using the traditional inverted plastic bag system. Finally, CO_2 enrichment applied around young seedlings growing in a nutrient solution will promote seedling growth and development. The use of CO_2 is able to cut the time *in vitro* from 12 to approx. 3–4 months. This represents a massive saving in culture cost and time. Other work has demonstrated that embryo transplantation is another way of producing seedlings from embryos, and to do this a surrogate nut is used as a nurturing host.

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

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

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

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

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

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

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

LPS/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	$792,651
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 outcomes

The broad aim of the Project was to provide the Philippines with the capability to systematically increase the productivity of its ruminant animals through genetic improvement. In order to develop better breeding programs, a system of data recording and performance evaluation for ruminant animals (beef cattle, sheep, goats and dairy buffalo) has been established that will operate as part of the National Genetic Resource Improvement Program (NGRIP) for livestock.

An effective system has been designed and implemented that allows for the collection of breeding and production data for various breeds and species of ruminant livestock run on government research and breeding stations and in collaborating herds. Procedures have been set up for sending these data manually or electronically into a multi-species database.

Filipino scientists and technicians have been trained in all the relevant techniques for implementing an advanced genetic improvement program for the various ruminant breeds and species. A number of project scientists have also undertaken post-graduate animal science training in overseas universities during the project. This is consistent with ensuring that the Philippines develop the capacity to run its own genetic improvement programs.

A prototype model of the software for data collection and storage was first put in place on the computer systems at ABRI in Australia and data collected in the Philippines were fed into this database for testing. The Alpha computers were later installed at the Bureau of Animal Industry and the Philippine Carabao Centre. The beef and small ruminant databases held at ABRI were transferred to the BAI and the carabao and dairy buffalo database held at ABRI was transferred to the PCC. Software developments to better handle species–specific requirements continued throughout the Project.

The standard BREEDPLAN system is currently in place at BAI enabling the analysis of performance data for the beef cattle. A customised version of BREEDPLAN has been installed for small ruminants (sheep and goats). A dairy-specific genetic evaluation system has been installed and tested at PCC.

The Animal Genetics and Breeding Unit at the University of New England undertook research on the breeding and production records in the central databases to estimate genetic parameters and fixed effects for the various ruminant species. Parameters for Philippine Beef were prepared by AGBU and utilised in GROUP (across-herd) and Interim GROUP BREEDPLAN analyses. The first Philippine Beef GROUP BREEDPLAN analysis was run in August 2004 and analyses have been run regularly since that time.

Similarly, AGBU supplied parameter files for the sheep and goat evaluations and these are now used in Within Flock BREEDPLAN analyses at BAI. AGBU also supplied genetic parameters for the analysis of the dairy buffalo data. This analysis is now being run at the PCC.

Training programs were undertaken to develop skills in the capturing of breeding and performance records to form databases for use in genetic evaluations, on the use of the software relating to these databases and on the extension of the results from the evaluations of the data. Early in the project scientists and field staff were trained in the electronic capture of on-farm records. Courses were provided in the use of farm-level PC programs—*Herd Magic* for beef and small ruminants, and *DairyStor* for dairy. Scientists were also trained in operation of the Alpha computers and in the software used in the integrated pedigree/performance database.

For the beef and the small ruminant programs, Workshops were provided that covered areas such as the interpretation and use of Estimated Breeding Values, effective performance recording, breeding objectives and operational procedures relating to Philippines BREEDPLAN. Reports and results from the respective BREEDPLAN analyses were also presented and discussed. These workshops were attended by staff from government organisations (including breeding stations) and private breeders and animal raisers.

The BAI has provided a number of training courses for sheep and goat raisers, scientists and technical staff. The training explained the basic considerations and procedures in the collection and recording of pedigree and performance data for small ruminants. The concepts were explained through hands-on training sessions. The PCC, with assistance from ABRI staff, also prepared and presented a workshop covering data collection and interpretation of EBVs for carabao and dairy buffalo raisers.

Considerable assistance has been provided on the design of breeding programs for the relevant species. The PCC has had a very tightly defined breeding program for the carabao but the beef and small ruminants have been less well defined. Preliminary discussions were held on these matters at the beginning of the project so that a good understanding could be developed of industry structure and economically important traits. These issues were regularly discussed, formally and informally, during the project's life. Presentations and discussions on breeding program design and, in particular, on the determination of breeding objectives were provided at all training workshops following the release of EBVs.

The project has made significant progress in combining breeding data from government and private breeding farms in a way that will add significantly to the power of the genetic evaluation. This is particularly evident in the Mindanao and Visayas region where a small group of participants who attended a workshop run by ABRI staff have now organised themselves into a formal system of regular meetings and farm visits. The project also has made significant progress in persuading private breeding farms to participate, particularly in the small ruminant program.

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 College of Science, Technology and Environment, Australia
Project Leader	Professor H. John Bavor Phone: (02) 4570 1264, (02) 4570-1423, mobile 0418 218 656 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	$754,155
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 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 outcomes

The team completed maps showing estimates of current land-use areas that included six major agricultural crops (irrigated rice, rainfed rice, corn, cassava, coconut and oil palm) and forestry/grassland areas. The land-use cover percentages were: agriculture usage 52%; grassland and shrub land areas 33%; woodlands 12%; wetland areas 1%; miscellaneous/built-up areas 1%. Watershed maps developed showed the area in three soil-depth classes, slope maps in six different slope percentage classes (0–3, 3–8, 8–18, 18–30, 30–50 and above 50) and a general erosion map in five different classes. Maps were produced as both stand-alone maps and as GIS data-layers.

Technical information gathered was incorporated into a GIS framework and database to support better decision-making via data and trend evaluation and modelling, for application to a wide variety of watershed management decision-making issues. Cropping and land-use suitability was 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 to support ongoing transfer of education and training to sustain good agricultural practices, conserve soil and water resources, improve farming practices and increase farm income.

Data gathered at the seven experimental erosion and runoff sites and three water sampling sites helped 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 were also determined. The sites include the following land-uses: agroforestry, woodland, cassava/corn, grassland, rainfed rice, irrigated rice and oil palm. Compiled in GIS format and linked database, the data provide a rich source of information for planning agencies and NGO groups when making presentations during farmer/community training activities.

A comprehensive dataset addressing agro-socio-economic issues in the watershed has been completed. It was compiled from farm surveys across the watershed—932 households from 114 barangays of 14 municipalities in 2000 and another 126 household in five municipalities in 2003. The dataset also included interviews and collected data from farmer cooperators at five project sites. A picture emerged of high poverty levels, rising unemployment and low per capita income. Farm productivity, with the exception of irrigated rice, fell below the national average.

Alternative cropping scenarios and present/future water management practices were considered in developing strategies to reduce sediment transport. 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.

The project introduced scientific methods and instrumentation to deal with soil and water resources research at a watershed scale rather that the conventional plot scale. These technologies and approaches have bolstered local capacity to monitor and evaluate data, yielded information to produce maps and database sets, and lifted capacity for predictive evaluation of management options via modelling based on empirically derived data.

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 Baños, Philippines Queensland Department of Primary Industries and Fisheries, Australia
Project Budget	$1,690,512
Project Duration	01/07/1997 to 31/12/2005 (Project extended from 01/01/2001 to 31/12/2005)
ACIAR Research Program Manager	Dr Greg Johnson

Project background and objectives

All the ASEAN countries, and Australia, produce papaya. 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. Hence, transporting the fruit within a country—let alone exporting it—causes large losses. Up to 40% of the harvest is lost in transit from the farmer to the consumer.

Postharvest ripening and senescence are controlled mainly by the gas ethylene, given off by many fruits in increasing quantities as they mature. Papaya and mango produce their own ethylene, and are therefore self-ripening and self-destroying. 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 applied similar genetic engineering techniques to the creation of modified papaya and also started 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 outcomes

Australia
The major outputs were the identification and cloning of two important genes in the ripening process and production of transgenic papaya trees. Approximately 100 transgenic lines were produced. Transgenic trees were evaluated in field trials and the main fruit characteristics analysed. A number of transgenic papaya lines were identified with fruits showing an increased shelf life. These lines show an increased fruit life but no other important changes in the quality of the fruits. In addition we developed tissue culture protocols for mango and produced transgenic tissues containing the 'Green Fluorescent Protein' gene that confers fluorescence upon illumination with UV light.

Philippines
Papaya
During the first three years of implementation of the project, we reported the cloning of the ripening-related ACC synthase (ACS2) gene from Philippine Solo papaya, preparation of the gene construct containing the ACS2 in reverse or antisense orientation, optimisation of somatic embryogenesis and regeneration of papaya, optimisation of particle bombardment conditions, transformation of somatic embryos via particle bombardment, selection and regeneration of putative transgenic papaya plants and growing out in the second-biosafety level screenhouse for evaluation.

For the extension phase, we selected nine papaya trees from six unique lines on the basis of molecular analysis and phenotypic traits. In general, the selected papaya trees had a good stand with normal sigmoidal growth and prolific fruiting habit, with 15 to 48 fruits upon reaching the first sign of ripening. The selected transgenic lines exhibited longer number of days from colour break to full yellow of 6 to 7 days compared with 5 to 6 days for control non-transgenic papayas. The difference in the number of days from full yellow to start of loss of firmness (and/or to rotting stage) was more pronounced: 6 to 14 days for selected transgenic lines compared with 2 days for control non-transgenic papayas. Selected transgenic papayas also were firmer—5.5 to 7.3 kgf compared with 0.9 to 1.2 kgf for control papayas at 12 days after color break.

The presence of the transgenes, the kanamycin resistance gene and the antisense ACC synthase gene was detected by using appropriate primers and PCR-based analysis. The transgenes were also detected in the leaves, fruits and peduncles of the transgenic papaya trees, indicating the non-chimeric character of the transformed plants. Southern blot analysis showed a single copy of the transgene in the selected transgenic lines.

We subjected the new transgenic papaya lines to various biochemical analyses such as proximate chemical composition, vitamin C and beta-carotene, total soluble solids or total sugars, and benzyl isothiocyanate (BITC) contents. At all three stages of the fruit (green mature, color break or 10% yellow, and 100% yellow), the values obtained for the different lines including the control were quite close to each other and were within the range reported in the literature. The results indicate that the transgenic papayas are substantially equivalent to the nontransgenic control papayas.

The selected transgenic and control papayas are undergoing further screenhouse evaluation and preparations for field testing are being made. Plans are also being made for biosafety and food safety tests that may be required by the concerned biosafety regulatory agencies in the Philippines. These transgenic papaya plants are the first transgenic crop developed in the Philippines.

Mango
For mango, the ACC synthase gene from ripe mango var ‘Carabao’ has been isolated, cloned and sequenced. A major output of this project is the establishment of optimum conditions for the somatic embryogenesis of mango var ‘Carabao’. The developed protocol can also be applied to other varieties of mango. Efforts now focus on identifying the conditions for complete plantlet regeneration from germinated somatic embryos. At this time, recovery of plantlets is very low and it takes a long period (about two years) to obtain plantlets with true leaves.

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

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

Project background and objectives

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

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

Project outcomes

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

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

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

Australian native fruits: Citrus australasica seeds demonstrated tolerance to desiccation and ultra-low temperatures, and had normal post-cryostorage morphology. Results on seed storage of *C. inodora* and *C. garrawayi* showed that these species have tolerance to desiccation and cryostorage, however reduced seedling vigour was observed. Seeds of both species survived cryopreservation with growth and acclimatization of plants post cryostorage. A micro-propagation protocol was established for three Australian native *Citrus* species (*C. australasica, C. inodora* and *C. garrawayi*) that was suitable for mass multiplication and medium-term storage of this valuable germplasm.

Somatic embryogenesis protocols were investigated for *C. inodora*, *C. garrawayi* and *C. australasica* using published methods and some media modifications. Embryogenesis was achieved in *C. inodora* and embryogenic tissue has been recovered from cryostorage using an encapsulation-dehydration protocol.

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

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

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

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

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

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

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

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

Projects under development

as at 30 June 2006

Bilateral

ASEM/2003/053	Linking smallholder vegetable producers in the Philippines to urban markets
ASEM/2006/059	Community Agricultural Technology Program
ASEM/2006/091	An Industry Organisation Model for Delivering Tree Seedlings to Smallholders in the Philippines
FIS/2005/172	Bêche-de-Mer Philippines
FIS/2005/173	IUU (Illegal, unreported and unregulated) management strategies in Philippine waters
HORT/2005/071	Disease control in Mindanao vegetable farming systems
HORT/2006/093	Development of a protected cropping system to enhance year-round production of high quality vegetables and strawberries in the Philippines
HORT/2006/110	Fruit production in the Philippines
HORT/2006/111	Horticulture export produce food safety and quality assurance Philippines
LWR/2004/078	Evaluation and adoption of improved farming practices on soil and water resources, Bohol Island, the Philippines
LWR/2005/060	Sustaining livelihoods and the environment in upland Mindanao through irrigated horticulture
PLIA/2006/018	Philippines policy environment and linkages projects
PLIA/2006/134	Policy environment and adoption of research case study from scoping study—Philippines

Multilateral

CIM/2006/176	Adding value to rice industries by solving the problem of chalky grains
FIS/2003/059	Sea ranching and restocking sandfish in Asia-Pacific

Philippines consultations

14–15 March 2006

Priorities for collaborative agricultural research between Australia and the Philippines were discussed at a series of meetings held between 14-16 March 2006 in Mindanao (Davao), Visayas (Cebu), Luzon (Los Baños and Manila), culminating in a plenary meeting on 17 March 2006 in Manila. Consultation meetings involved senior ACIAR staff and representatives of relevant Philippines government departments, universities, national and regional research consortia and research organisations, private sector associations and non-government organisations. These priorities are not to be considered as officially sanctioned priorities of the Government of the Philippines. ACIAR will use them as a framework when assessing proposals for collaborative projects, subject to further advice and information from the Philippines. Researchers intending to propose collaborative research projects should, in the first instance, approach one of ACIAR's Research Program Managers.

At the consultation, several overarching issues were identified. It was agreed that the main aim of ACIAR cooperation is to assist the Philippines to increase the productivity, marketability and international competitiveness 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 research results and 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, horticultural, forestry and livestock products 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. Efficient use of water will assume increased importance. ACIAR's Philippines program will have an increasing emphasis on involvement of local partners such as 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. Linkages of regionally-based delivery organisations and research organisations and policy makers based centrally in Manila and Los Baños will be fostered. ACIAR's program will increase its emphasis on the southern Philippines, within a limited number of focal provinces in Regions X and XI (Mindanao) and Regions VI, VII and VIII (Visayas).

Agreed priorities for training include support for postgraduate scholarships in Australia for scientists and economists working on ACIAR projects and short-training courses that strengthen capacity to apply results of research to the needs of farmers and policy makers. Training will comprise courses in economics and social science for biophysical scientists; participatory agricultural research/extension; project evaluation and impact assessment; research business management and commercialisation; information and communication technology for R&D and training in supply chain management.

Agreed priorities for collaborative research and development programs are listed under thematic areas:

Increasing the market competitiveness of Philippine agricultural products.
Better systems and policies for meeting market specifications

- Identification of farmer incentives for adoption of grains and horticultural postharvest systems improvements
- Facilitation of uptake of grains and coffee postharvest technologies, including management of storage pests and of mycotoxins
- Development of new quality management and food safety standards and systems for horticultural products including organic products
- Economic analysis of marketing chains and channels for perishables including determination of consumer preferences
- Improving alliances between fruit and vegetable suppliers, processors, institutional buyers and marketers
- Analysis of best practices for financial service schemes for small farmers

Higher returns from horticultural products

- Protected cropping technologies and reduction of inputs for production of crucifers, salad vegetables and strawberry
- Nutrient and pesticide management, particularly fertigation systems to save costs and reduce residues in vegetables and fruit
- Selection and clonal propagation of new quality mango strains and control of major pests and diseases (fruit fly, pulp weevil and anthracnose)
- Shelf life extension, product development, packaging, quality and sanitary and phytosanitary standards for markets for crucifers, salad vegetables, jackfruit, mango and new tropical fruit crops
- Management of bacterial wilt and other soil-borne diseases in solanaceous and crucifer vegetables, through better varieties and biofumigation technologies

Region-specific priorities

- Varietal improvement and propagation of jackfruit for quality and adaptability (Visayas)
- Collection and evaluation of native vegetable (e.g. eggplant) germplasm (Visayas)
- Collection and evaluation of germplasm and development of cultural packages for new tropical fruit crops (Visayas)
- More efficient production systems for disease-free seed potato (Mindanao)
- Application of control methods for phytophthora in durian and diamondback moth in brassicas (Mindanao)
- Improvements to postharvest shelf life and handling of salad and semi-temperate vegetables and strawberry (Mindanao)
- Integration of vegetable production into agroforestry systems (Luzon)

Competitive and sustainable aquaculture production

- Mariculture-based strategies to provide livelihoods and enhance locally-managed fisheries with an initial emphasis on sea cucumbers
- Assessment of the impacts of mariculture on community livelihoods of small fishers
- Review of opportunities and constraints in the supply chain for key aquaculture products, particularly grouper and mud crab
- Management of Viral Nervous Necrosis of marine finfish
- Integrated use and management of on-farm ponds and small water impoundments for freshwater fish production
- Opportunities for application of the results from ACIAR aquaculture projects in other countries to the Philippines

Farmer–based land and water resource management for profitable and sustainable agriculture

- Catchment-scale adaptation of Landcare-type activities for soil and water conservation in Visayas
- Water resource management (including groundwater and water harvesting) for high-value vegetable and fruit crops
- Valuation and financing mechanisms for environmental services in watersheds for soil and water conservation
- Integrated nutrient management for low-input farming systems
- Utilisation of urban waste and treated wastewater for peri-urban agriculture
- Market identification and utilisation of industrial trees and fast-growing agroforestry species
- Propagation systems for indigenous trees for soil and water conservation

Addressing regulatory, policy and technical constraints to the adoption of research outputs

- Development of simple replicable financial/business models for agribusiness development of small farms
- Application of better extension models for packaging earlier research results (e.g. on livestock production and health, horticulture, aquaculture and agroforestry)
- Identifying and addressing local and national policy constraints to adoption of research, including: land use, land tenure, taxation and transportation policies, sanitary and phytosanitary standards, and intellectual property rights
- Policy constraints to agroforestry development on small farms
- Policy constraints to the control and management of illegal, unregulated and unreported (IUU) fishing

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@aciar.gov.au, or may be requested through ACIAR's Philippines office. Publications may also be downloaded from ACIAR's website, www.aciar.gov.au.

Impact Assessment Series

9 Sulphur test KCl-40 and growth of the Australian canola industry
11 Postharvest R&D concerning tropical fruits
14 Improved drying of high moisture grains
19 Measuring the poverty impact of ACIAR projects: a broad framework
21 Improving methods in diagnosis, epidemiology, and information management of foot and mouth disease in SE Asia
35 Review of the returns to ACIAR's bilateral R&D investments
38 Future directions for ACIAR's animal health research
39 Benefits to Australia from ACIAR-funded research
41 ACIAR and public funding of R&D: submission to the productivity commission study on public support for science and innovation

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
120 Better-practice approaches for culture-based fisheries development in Asia
121 Planters and their components: types, attributes, functional requirements, classification and description
124 Heart rot and root rot in tropical acacia plantations

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
121 Evaluation and performance of permanent raised bed cropping systems in Asia, Australia and Mexico

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
56 Feeds and feeding for inland aquaculture in Mekong Region countries
58 Evaluation of international provenance trials of *Casuarina equisetifolia*
59 Using seasonal climate forecasting in agriculture: a participatory decision-making approach
61 Production technologies for low-chill temperature fruits

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
60 Economics and marketing of the live reef fish trade in Asia–Pacific