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Australian Centre for
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ACIAR Annual Report 2008–09
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Letter of transmittal from Chief Executive Officer

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The Hon Stephen Smith MP
Minister for Foreign Affairs

Dear Minister

ACIAR Annual Report 2008–09

It is my pleasure as the Chief Executive Officer to present to you the Annual Report of the Australian Centre for International Agricultural Research for the year ended 30 June 2009.

The Report has been prepared in accordance with section 39 of our enabling legislation – *Australian Centre for International Agricultural Research Act 1982*, as amended.

Consistent with section 49 of the *Financial Management and Accountability Act 1997*, I have taken steps to ensure that the annual financial statements have been prepared in accordance with the Finance Minister's Orders. The Report includes the Centre's audited financial statements, certified by the Australian National Audit Office, as required by section 57 of the *Financial Management and Accountability Act 1997*.

In presenting the Annual Report, I take the opportunity to acknowledge the important contribution made by ACIAR's former Chief Executive Officer, Mr Peter Core, ACIAR staff and commissioned research organisations, to achieving more productive and sustainable agricultural systems for the benefit of developing countries and Australia through international agricultural research partnerships.

Yours sincerely

Dr Nick Austin
Chief Executive Officer
ACIAR
October 2009

cc The Hon Bob McMullan MP
Parliamentary Secretary for International Development Assistance

The Hon Duncan Kerr SC MP
Parliamentary Secretary for Pacific Island Affairs

ACIAR
Research that works for developing countries and Australia
www.aciar.gov.au

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Highlights

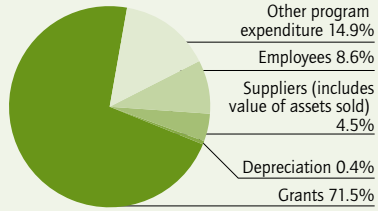
About ACIAR

ACIAR forms part of the Australian Government's international development assistance program and works towards the aid program's objective of assisting developing countries to reduce poverty and achieve sustainable development in line with Australia's national interest.
The core principles of the aid program are:

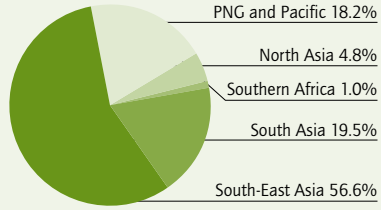
- accelerating progress towards the Millennium Development Goals
- a recognition that while economic growth is the most powerful long-term solution to poverty, economic growth will not, by itself, deliver fair and stable societies
- a strong emphasis on the Asia–Pacific, while also increasing our efforts in Africa and South Asia
- an emphasis on the power of education to promote development
- a commitment to continue to improve effectiveness.

ACIAR works collaboratively with AusAID in areas of mutual priority, with both organisations contributing to the whole-of-government emphases of the aid program. The Centre encourages Australia's agricultural scientists to use their skills for the benefit of developing countries and Australia. ACIAR funds research projects that are developed within a framework that reflects the priorities of Australia's aid program and national research strengths, together with the agricultural research and development priorities of partner countries.

ACIAR expenditure 2008–09



Research expenditure by region



Key outcomes

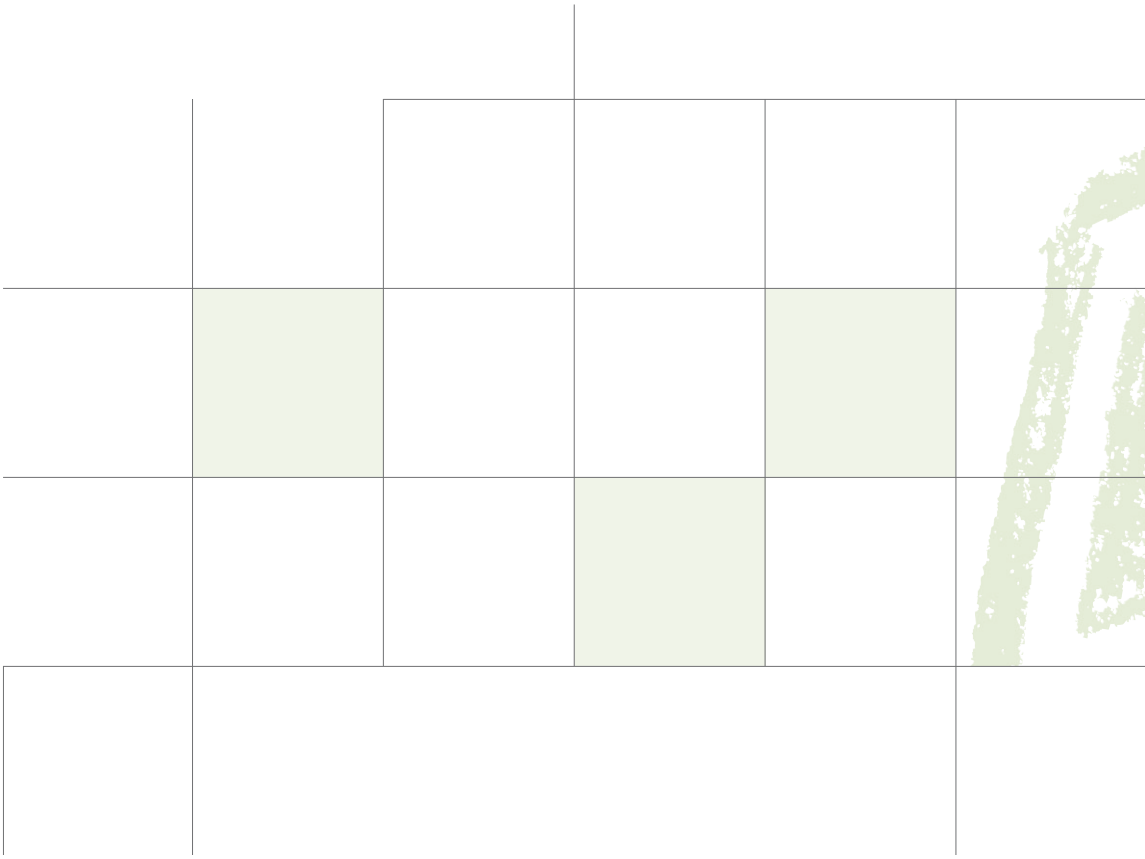
- Seventeen new bilateral projects were commenced in 2008–09 across the five regions in which ACIAR operates.
- Six new multilateral projects were commenced.
- Five independent impact assessments of past ACIAR projects estimated benefits accruing to end users of A$1.7 billion, with an average benefit:cost ratio of 67.9:1.
- More than 300 research scientists from seven developing countries benefited from participation in formal training courses sponsored or held by ACIAR.
- ACIAR communicated the results of research it funds through the dissemination of more than 35,000 hard copy publications, with 210,000 visitors to the ACIAR website downloading an average of 66,000 PDF copies of ACIAR publications each month.
- Productivity savings of $302,687 were achieved during 2008–09.
- New solar panels were installed at ACIAR House, contributing to energy reductions of 16,000 kilowatt hours, as part of ACIAR's efforts to reduce its environmental footprint.

The Millennium Development Goals

The Millennium Development Goals (MDGs) are the United Nations agreed goals for halving poverty by 2015. ACIAR projects have contributed towards the achievement of the eight MDGs aimed at halving global poverty by 2015. Projects in ACIAR partner countries made significant contributions to a number of the goals. For example, in East Timor the AusAID-funded, ACIAR-managed Seeds of Life project has:

- helped participating farmers improve food security through increased yields (MDG 1: Eradicate extreme hunger and poverty)
- helped women participating in the project improve productivity by reducing the time spent on collecting wild sources of food, decreasing their labour, with both men and women involved in nearly all activities associated with cultivating food crops (MDG 3: Promote gender equality and empowerment of women)
- created surpluses which are being sold for a profit, with the money used for education (MDG 2: Achieve universal primary education) and health (MDG 4: Reduce child mortality, MDG 5: Improve maternal health and MDG 6: Combat HIV/AIDS, malaria and other diseases)
- collected seed varieties grown locally for storage in gene banks (MDG 7: Ensure environmental sustainability).
- ACIAR's partnership model of engaging Australian research institutions, the centres of the Consultative Group on International Agricultural Research and developing-country research institutes are building partnerships for development (MDG 8: Develop a global partnership for development).

Icons designed by UNDP Brazil©



Commission Chair's and Chief Executive Officer's review

Commission Chair's and Chief Executive Officer's review

Dr Meryl Williams
Commission Chair

Dr Nick Austin
Chief Executive Officer

We would like to acknowledge that credit for many of the achievements in this annual report is owed to the former CEO, Mr Peter Core, who finished his 7-year term at ACIAR at the end of July 2009. The success of the achievements and activities of the last year largely rest with him and the dedication of the ACIAR staff.

We are struck by the strong and unwavering commitment of the former CEOs to the Centre's vision—ACIAR looks to a world where poverty has been reduced and the livelihoods of many improved through more productive and sustainable agriculture emerging from collaborative international research.

Partnerships and relationships

For a comparatively small organisation, ACIAR's reach and impact is deep and wide. This is because it has established over almost three decades a highly successful model of partnership for supporting international agricultural research. Those partnerships have been nurtured and expanded in 2008–09, including with the International Fund for Agricultural Development, the Asian Development Bank, World Bank, World Vision and various commercial businesses and community-based organisations.

The Smallholder Agribusiness Development Initiative (SADI) in Indonesia exemplifies ACIAR's experience in leveraging research and funding relationships to maximise outcomes and benefits. The program is funded by AusAID, with ACIAR drawing together strategic partnerships among research providers, farmer groups and private companies like the global confectionary and pet food corporation Mars Incorporated, to improve cocoa production by smallholder farmers.

ACIAR has long-standing relationships with many developing countries in our region and the partnership modality is instrumental in generating genuine collaboration in research with our developing-country partners. The specialised technical nature, and often long lead times, in agricultural research, is well served by a partnership approach. Training and capacity building are an important component of the partnership model, ensuring that expertise to continue agricultural research, beyond the life of any individual project, is present. ACIAR invested more than $7 million in education, through fellowships, short training courses and in-project activities during the financial year.

2009 marked the 25th anniversary of ACIAR's involvement in Indonesia. Australia's Ambassador to Indonesia, Mr Bill Farmer AO, hosted a reception in January to mark the event. Indonesia was one of the first partner countries in which ACIAR established projects. Today it is ACIAR's largest partner country with nearly $11 million invested this year in projects and training activities. ACIAR has a broad partnership in agricultural research with Indonesia, including collaborative programs with the three main Ministries—forestry, fisheries and agriculture—and also across provinces. The work ranges from improving export market access for commercial Javanese mangosteen growers, through to improving basic food security for subsistence highland communities in Papua.

ACIAR has also supported over 50 Indonesians to complete postgraduate study in Australia, many of whom are now making a valuable contribution to Indonesia's economic and social development.

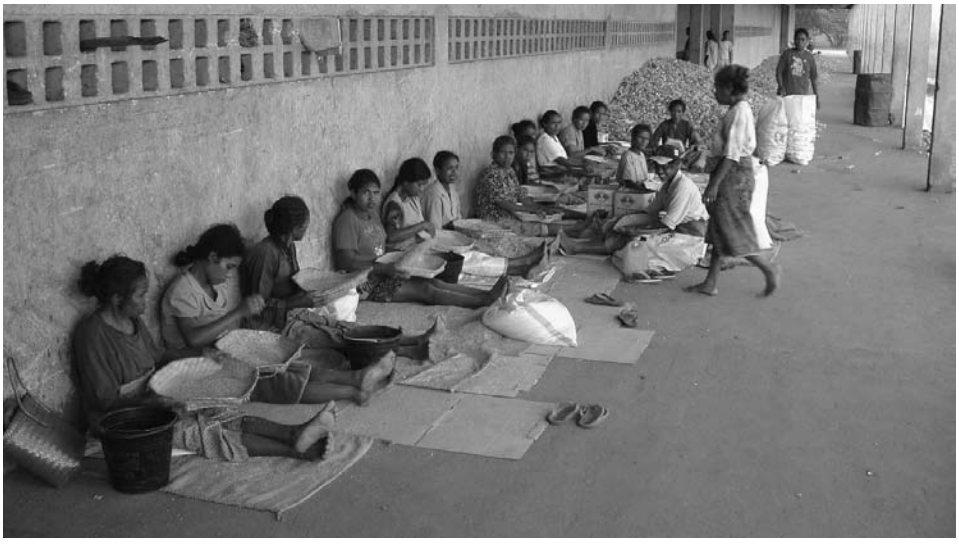
Food security focus

For most in the developing world, food security has become more tenuous since the 2008 global food crisis. Food security has been ACIAR's focus since its inception. As a niche organisation specialising in development-relevant agricultural research, ACIAR has been well placed to join global efforts to stem climate-change impacts on the world's food production and respond to the challenge of food security.

Global food security, climate change and the financial crisis dominated national and global agendas over the last year and ACIAR has welcomed the opportunity to contribute to the Australian Government's response. In 2008–09 the food security focus has shifted to the food system, economic structural issues and the short- and long-term solutions and priorities needed to address these challenges. The 2008 Crawford Fund Conference on Agriculture in a Changing Climate sounded the food security alarm, discussed efforts to deal with the negative impacts of climate change on food security and the consequent expanded mandate for the Consultative Group on International Agricultural Research (CGIAR). The Crawford Fund also released its taskforce report in November 2008, 'A Food Secure World: How Australia Can Help', on the implications of the world food crisis and how Australia can play a role in world food security, generating further debate and consideration across a range of audiences in Australia.

Whole-of-government initiatives

ACIAR continued to work collaboratively with AusAID in areas of mutual priority, with both organisations contributing to the whole-of-government emphasis of the aid agenda, including several major joint programs with AusAID–



East Timorese women are benefiting from the improved crop varieties being introduced through the 'Seeds of Life' project. [Photo: Brad Collis]

An Indian woman harvesting her family wheat crop.

in Indonesia, Papua New Guinea, East Timor, Cambodia and Pakistan—and ACIAR is managing two significant projects, co-funded by AusAID, one in Iraq and one in Afghanistan.

In 2008–09, in response to the global food crisis, several initiatives were designed and implemented to enhance food security in poorer partner countries and lagging regions, identified in conjunction with partner country priorities and partner country strategic development plans. These projects have a strong focus on productivity enhancement, and include work targeted at: resilience of rice-based farming systems to climate change in Bangladesh, India, Cambodia and Lao PDR; intensification of rice-maize production in Bangladesh; sweetpotato–pig systems in Papua, Indonesia; and sustainable crop-livestock production systems in upland Vietnam and in south-central coastal Vietnam. Two significant whole-of-government initiatives—SADI in Indonesia and the Australia-Pakistan Agriculture Sector Linkages Program (ASLP)—were both extended during the year, with the ASLP extension, until 2011, announced by the Minister for Foreign Affairs, the Hon Stephen Smith MP, during a visit to Pakistan in February. The SADI extension followed a mid-term review, conducted at the end of 2008, which recommended that Phase 2 begin in 2010.

In 2008–09 ACIAR has actively participated in a range of inter-agency activities to develop the Government-wide food security strategy which was unveiled in the Federal Budget in May 2009 as the International Development Assistance Program's 'Food Security through Rural Development Initiative'. Research proposals and associated partnerships were formulated to underpin the work ACIAR will undertake in the areas of food security and climate change. The programs that will help meet these challenges include new program thrusts that:

- safeguard food security and climate-change adaptation and mitigation in the rice-based farming systems of South Asia and South-East Asia
- exploit opportunities for developing high-value agricultural, forestry and fisheries products in Pacific island countries
- increase financial support to the CGIAR to help build a stronger CGIAR system.

In addition, ACIAR will also be involved in delivering key elements of the 'Food Security through Rural Development Initiative' in Africa though a project focusing on maize-based farming systems for eastern and southern Africa—this will be the largest single project undertaken by ACIAR. The Centre has been involved in research projects in Africa since 1983 and welcomes the enhanced engagement in Africa and opportunity to help to strengthen the ability of countries in Africa to address food insecurity.

The 2009–10 International Development Assistance Budget represents the scale-up of Australian aid to maintain progress towards the Millennium Development Goals (MDGs). The associated increased funding to ACIAR of $63.6 million, an increase from $52.3 million in 2008–09, is testimony to the track record of achievement the Centre has in delivering results. It recognises the importance of lifting productivity on a sustainable basis over the longer-term as a key mechanism for strengthening broader-based

A young girl with her chicken at a Newcastle disease community chicken vaccination day, Mozambique.

economic growth in rural areas. Our increased funding from 2009–10 places significant responsibilities on ACIAR to ensure that this rural development is catalysed.

Climate change

Agriculture depends on the sustainable use of natural resources and, for this reason, will be more directly and significantly affected by climate change than other sectors of the economy. Agriculture is also a contributor to climate change. Developing countries are more likely to be affected by climate change because they rely more on agriculture for employment and contribution to their economies. The challenge of climate change has therefore also been a focus of resources and interactions in the last year, with the Garnaut Review delivered to the Government on 30 September 2008. In the context of ACIAR, the report advocates promoting collaborative climate-related agricultural research to assist developing countries. The review recommended that the mandate of ACIAR be explicitly expanded to encompass climate change in its biological, biophysical and social science dimensions.

ACIAR has maintained a diverse portfolio of projects relating to prediction of climate variability, adaptation of farming systems and the scope of agricultural greenhouse gas mitigation.

Notwithstanding the important Garnaut Review observations, in 2008–09, ACIAR began building on this existing and past project portfolio by establishing a dedicated Climate Change Initiative, focusing on adaptation to climate change in rainfed agricultural regions in Lao PDR, Cambodia, Bangladesh and parts of India. The program's particular focus will be more efficient use of water resources, but will also include seasonal climate forecasting, crop modelling and capacity development. In the 2009–10 Federal Budget ACIAR received additional funding for this program so that it could be expanded geographically to irrigated rice-based systems of the Mekong Delta in Vietnam, which produces most of the country's rice.

CGIAR reform process

The CGIAR, a strategic partnership of 64 members supporting 15 international agricultural research centres, agreed at its Annual General Meeting held in Mozambique in December 2008 to adopt an agenda for reform. At the heart of the reform agenda is a framework that changes the partnerships between donors and individual centres to create greater certainty in funding arrangements through a centralised Fund. ACIAR has been closely involved in the development of the reform framework.

The key changes centre on the creation of a multi-donor CGIAR Central Fund and of a Consortium Board to oversight programs supported by the Central Fund. The Fund will be managed by a Fund Council, chaired by the World Bank. This Council will be responsible for the oversight of the Fund and the provision of multi-year financing to the Consortium Board.

Under the new framework individual centres would pass some of their authority over to the Consortium Board, trading autonomy but also uncertainty in funding arrangements, for longer-term funding arrangements that offer greater certainty. By establishing a Consortium arrangement transaction costs should be reduced. Duplication of research efforts should also be

Cattle in Cambodia. [Photo: Brad Collis]

minimised, with projects linking the expertise of centres under a common purpose. The Consortium will help direct secure funding streams to projects within broader mega-programs, covering a range of overarching research priorities, such as water or staple food production.

The Australian Government, through ACIAR, currently contributes around $10 million a year to the centres of the CGIAR. This support is projected to rise to around $14 million by 2012–13. The Government's intention is that a significant proportion of this expanded support to the CGIAR in 2009–10 will be directed to specified mega-programs oversighted by a Donor Council and executed by the Consortium.

Corporate governance

The ACIAR Commission continued to play a key strategic advisory role to the Centre and the Minister for Foreign Affairs, including on: the reform of the CGIAR; strategic advice on development of a climate-change initiative and development of a food security strategy in Africa through the 'Food Security through Rural Development Initiative'; oversight of the transformation of ACIAR's program strategy in the Pacific; and strategic advice on development of a policy statement on biotechnology.

The new ACIAR Corporate Plan 2008–2012 was released with a focus on commitment to the MDGs and targeting three areas for future directions: greater focus on community impacts; alignment with stakeholder priorities and; investments to achieve sustainable development.

The CEO recruitment process was undertaken in 2008–09 in line with the Australian Public Service, 'Merit and Transparency: Merit-based selection of APS agency heads and APS statutory office holders' and the selection panel was chaired by the Secretary, Department of Foreign Affairs and Trade. The Minister for Foreign Affairs, the Hon Stephen Smith MP, announced the appointment of the new CEO for a 5-year term from 31 July 2009.

Project management and processes

An external strategic review of ACIAR's research project contracting framework was also undertaken to assess the efficacy of the overall project framework and its ability to contribute to the

achievement of strategic and operational corporate objectives and the development agenda. It covered research and development projects and ex-post adoption studies and ex-post impact assessment studies. The review delivered positive findings on the overall efficacy and quality of the administration and management of ACIAR's research project contracting framework; and made observations and recommendations on a range of strategic matters for the attention of ACIAR management.

As a specialist, research-funding agency, ACIAR aims for continuous improvement to project management processes, the research project framework and outcomes. In 2008–09 the Centre continued to improve the processes around its selection of projects, focusing on developing fewer projects via the implementation of larger, multidisciplinary projects aligned to stakeholder priorities and Australian comparative advantage in research. These projects incorporate special attention to the identification of adoption and impact pathways.

Two new collaborative websites were developed to facilitate communications within large projects underway in the Philippines and Vietnam. Upgrades to ACIAR's record management system and the project information database were also undertaken to reflect process improvements and to further integrate best practice administrative processes.

Outlook

For ACIAR, the near future will be focused on scaling up our activities to ensure that the initiatives announced in the May 2009 Federal Budget deliver results. These activities address some of the biggest challenges facing agriculture, and the world—climate change, food security and poverty reduction.

ACIAR plays a small, but important role in Australia's Aid Program; with the aim to identify and find solutions to the agricultural problems that confront smallholder farmers.

The Hon Stephen Smith MP, Minister for Foreign Affairs, with Mr Peter Core, former CEO, and Dr Nick Austin, incoming CEO.

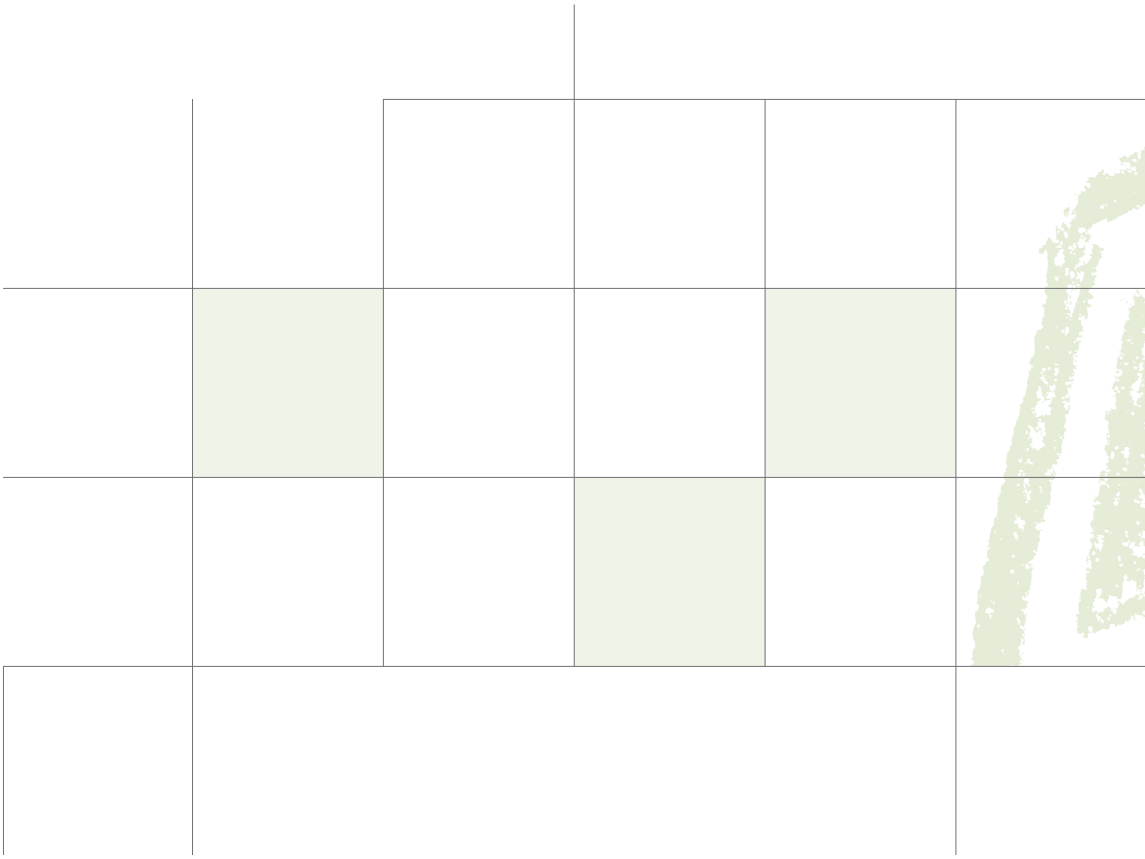
Addressing these problems can help these smallholders, who the World Bank estimates make up half of the world's poor, by improving the productivity of their agricultural enterprises and opening up market opportunities. Through this, the incomes of families can be lifted, allowing money to be spent on food, health and education opportunities. ACIAR's research complements the initiatives undertaken by AusAID in these areas, as well as governance, gender, disability and others.

The broader the applications of ACIAR research the greater the potential for smallholder farming sectors in developing countries to become a catalyst for economic growth in rural areas. ACIAR will continue to address these challenges through its partnership approach, and deliver projects that reduce poverty and achieve sustainable development.

Finally, our thanks go to the ACIAR Commissioners, the Policy Advisory Council and ACIAR team—the staff and research partners here and overseas—whose commitment, passion and professionalism continue to drive the delivery of sustainable, resilient and productive farming systems in developing partner countries.

Dr Meryl Williams
Commission Chair

Dr Nick Austin
Chief Executive Officer



The year in review—regional achievements

Papua New Guinea and the Pacific

Cossey Yosi, a PNG forest scientist, is studying for his PhD at the University of Melbourne as an ACIAR John Allwright Fellow. Mr Yosi, whose home village, Zare in Morobe Patrol Post, is surrounded by the pristine forest of the Waria Valley, is working to identify ways for PNG communities to sustainably manage the forests that have already been logged by commercial operators.

Financial year	Regional expenditure (A$)	Percentage of total project expenditure	Commission target as percentage of expenditure
2008–09	7,864,307	18.2%	> 20%
2007–08	7,324,114	19.4%	> 20%
2006–07	8,194,666	20.8%	> 20%

Papua New Guinea

AOP budgeted expenditure in 2008–09	$4,918,724
Actual expenditure in 2008–09	$4,704,897
Expenditure in 2007–08	$4,530,371
Expenditure in 2006–07	$5,050,940

Key performance indicators	Performance 2008–09
Social, cultural and technical constraints to increasing smallholder productivity and income in the oil palm and cocoa sectors identified, and promising technologies disseminated	Three ongoing projects focus on increasing smallholder returns from oil palm and cocoa production; introducing improvements in smallholder crop husbandry skills and integrated management of natural resources, pests and diseases; and promotion of commercial sector partnerships with smallholders.
Introduction of high-value species to smallholders for efficient and sustainable production of timber in forestry and agroforestry systems in at least one province	High-value species including teak have been introduced into traditional agroforestry systems, and teak seedlings distributed in response to strong demand from communities in the Markham and Ramu valleys, Madang province.
Development and dissemination of improved feeding strategies and completion of training programs to increase farmer skills in pond husbandry in village-based aquaculture in at least two districts	Fish husbandry skills were improved for cooperator farms in Morobe and Eastern Highlands provinces through training workshops held in Southern and Eastern Highlands provinces with 295 participants, with a particular focus on women farmers.
Initial strategies developed to reduce threat of coffee berry borer and impact of cocoa pod borer on smallholder farmers	A strategy to contain and mitigate the threat of coffee berry borer, not yet found in Papua New Guinea (PNG), has been developed, focusing on raising awareness and preparedness while promoting integrated pest management practices. A strategy for cocoa pod borer, already established in PNG, emphasises training farmers in integrated control practices while raising community and industry awareness to slow pest spread.
Technologies developed to increase sweetpotato crop yield through appropriate management of soil and nutrients	Farmer evaluation and multiplication of sweetpotato varieties on the northern coast of PNG and the management of soil fertility in sweetpotato-based cropping systems of the highlands have provided appropriate technologies to increase productivity by efficient management of soil and nutrients.
Direct linkages between at least three AusAID-funded Agricultural Research and Development Support Facility (ARDSF) projects and ACIAR research outputs	Two AusAID-funded ARDSF–Agriculture Innovation Grants Scheme projects are linked to ACIAR research outputs on pyrethrum and on marketing systems for fresh produce.
At least 40% of new projects designed to have significant farmer or policymaker impacts within 5 years of completion	Three of five projects under design or which commenced in PNG in 2008–09 are designed to have immediate impact.

Position

Papua New Guinea (PNG) is one of Australia's most important development partners. Village-based agriculture supports more than 70% of the population, contributing both to food security and significant export crops. ACIAR's program in PNG supports the goals of the AusAID program, focusing on sustainable broad-based economic growth. With more than 85% of the population living in rural areas, developing agricultural industries and smallholder cash crops is critical to achieving this goal. Both ACIAR and AusAID work with PNG Government agencies to build sustainable institutions, with ACIAR focusing on building capacity in agricultural research, including through support for training and fellowships.

The ACIAR program aims to achieve practical impacts for PNG smallholders, consumers, industry and government through applied technical, social, economic and policy research. This is delivered through five subprograms: focusing on policy constraints to adoption of agricultural technologies; enhancing smallholder incomes from horticulture and root crops; improving smallholder returns from export tree crop production; developing new smallholder fisheries, aquaculture and forestry livelihoods; and biosecurity and sustainable resource management. Projects are clustered together, where possible, to address problems faced by major staple food and high-value commodities, such as sweetpotato, coffee, oil palm and cocoa.

Achievements

Subprogram 1: Addressing social, cultural and policy constraints to the adoption of agricultural technologies

Subsistence farmers in PNG and the Pacific islands are vulnerable to the impacts of climate variability and climate extremes. The ability of PNG to respond to these challenges will be influenced by local, institutional and national organisations having an **early warning system based on seasonal climate forecasts**. Building local capacity in use of this technology is seen as a major step towards meeting the challenges of climate variability. For example, coffee production can fluctuate widely due to drier or wetter conditions associated with the El Niño and La Niña phenomena. Understanding the impacts of climate on PNG's agriculture, and the ability to predict these events with sufficient lead time for government and farmers to take

Smallholder farmers growing coffee attend a meeting

Dr Gamini Keerthisinghe, ACIAR Research Program Manager, Soil Management and Crop Nutrition, on a project visit in the PNG Highlands with a local boy carrying utensils for his father to cook lunch.

remedial action and adapt to a changing climate, is the subject of a project retrieving long-term rainfall data for PNG. This is being used to determine the relationship between rainfall data and the El Niño Southern Oscillation (ENSO). A key component of the research involves investigating the utility of drought warning tools to help maintain food security (sweetpotato) and farm income (coffee). Good-quality monthly rainfall data were assessed for 10 stations with a length of record between 52 and 106 years. These data were used in SCOPIC (seasonal climate outlook for Pacific island countries) software for analysis of drought and to determine seasonal climate forecasts based on key ENSO indices.

Government policies, and the quality and reach of institutions (especially those that underpin market transactions and property rights) play a key role in shaping the incentives for primary producers to adopt outputs of technical research. While ACIAR has previously included studies on policy issues in its portfolio, it is now embarking on a more concerted effort to look at the **effect of policy on the probability of its projects having favourable impacts**. A project is identifying strategies to help PNG deal with situations where the policy and institutional environment hinders the adoption of new technologies, or diminishes the benefits of adoption. The project team has developed its information base by researching the past portfolio of ACIAR projects in PNG, referring to adoption studies, impact assessments, working papers, project annual and final reports as far back as the late 1980s. This detailed information set is helping to identify and assess a range of relevant policy, institutional and economic factors that may affect project impact. A deeper assessment, through examination of a smaller set of projects, of how economic, policy and institutional factors affect adoption and impact has begun.

PNG has substantial stocks of tuna within its Exclusive Economic Zone, some of which have been exploited by foreign fishing vessels paying access fees in exchange for fishing rights. PNG has adopted a policy of domestication of its tuna fishery, which involves encouraging domestic longline vessels and expanding the proportion of the purse seine catch taken by locally based vessels supplying domestic canneries. **Further development of the tuna fishery** will take the form of a change in the balance between the longline and purse seine fisheries, or a change in the allocation of the purse seine catch. As locally based purse seiners displace the purse seine fleets of distant water fishing nations, access fees paid by the latter will decline. Domestic

fishing must generate, at least, corresponding benefits for the host nation. A possible income source exists through foreign companies that have expressed interest in setting up tuna processing operations in PNG.

Staff members of the National Fisheries Authority need help in developing and applying a method to analyse the economic benefits and costs to PNG of competing cannery proposals, a situation common to a number of countries in the Pacific islands region. The project developed a benefit:cost model for application to proposals for domestic development of the tuna industry, quantifying the range of benefits and costs to the host country from a domestic tuna cannery. Since the model also measures the net benefit to a foreign firm proposing investing in a cannery, under a range of possible financial arrangements, it can be used as a tool in negotiating any tax or similar concessions requested by the firm. PNG staff had full involvement in both the survey work at the cannery and development of the model, equipping them with the skills to apply the model to new proposals.

Subprogram 2: Enhancement of smallholder incomes from horticulture and root crops

Sweetpotato is an important food staple in PNG, with a suite of projects underway to lift productivity. A project to improve **marketing efficiency, postharvest management and value addition of sweetpotato** began by mapping the social, economic and physical components of sweetpotato supply chains. The project's economic and technical teams worked together to develop an interdisciplinary approach to supply chain analysis. On the economic side, the project team conducted interviews with the various participants in the supply chain from the highlands to coastal markets. On the physical side, the team carried out consignment trials across three different supply chains to determine where major losses were occurring and where intervention was warranted. On the social side, focus groups for women were conducted in Western Highlands and Eastern Highlands provinces, discussing gender division of labour, income distribution and problems encountered by women farmers in relation to sweetpotato marketing.

The potential for **improving productivity of sweetpotato-based systems** by addressing soil fertility as a major factor in yield decline has been demonstrated in an earlier study. Follow-on research is assessing and quantifying soil and water processes in highland soils, working with farmers to develop and implement improved nutrient and water management options for sweetpotato-based cropping systems (with a focus on existing indigenous soil management systems), and enhancing PNG's soil research capacity. One facet of the research has been a comparative nutrient analysis of different kinds of sweetpotato grown in the local village gardens. Growth trials took place at field sites in Eastern Highlands, Simbu and Western Highlands provinces. The treatments applied investigated a range of tillage methods (large mounds, small mounds and beds), coupled with mulch application and composting using different plant material, both burnt and unburnt. Useful information on tuber yields and quality parameters affected by the various treatments are being investigated to find promising technologies to increase productivity and quality of sweetpotato.

The decline in sweetpotato yields is also due to a combination of pests, diseases and physiological factors. A project to introduce an integrated pest management (IPM) approach is helping to **reduce pest and disease losses**. During the past year the project has made some significant achievements. Prior to its commencement there was minimal scientific evidence to support the assumption that the sweetpotato yield decline phenomenon could be caused by viruses and virus complexes. The project has now identified four yield-limiting viruses in PNG. Investigations are also underway to determine if there may be virus interactions causing further yield reductions. Skills in virus indexing combined with serological virus testing have developed considerably in both PNG and Australia. PNG successfully tested 24 varieties

for viruses using *Ipomoea setosa* grafting and confirmation by ELISA testing. This improvement in diagnostic capability in both PNG and Australia will improve the soundness of disease identifications and better assist in inter-country germplasm exchange.

Subprogram 3: Improving smallholder returns from export tree crop production and marketing

Changes in coffee production have created a widely held perception that the **quality of PNG coffee has fallen** and, as a result, the price of PNG coffee has declined relative to the world price. A suite of projects is working to address several significant issues, including a shift from larger estate production to smallholder production. A project has focused on identifying smallholder strategies to improve coffee quality at the community level. Three possible strategies to improve the quality of coffee produced by smallholders have been investigated: encouraging the sale of red ripe cherry direct to the wet mills; adopting standardised processing systems at the village level; and pursuing Fairtrade, Rainforest Alliance, Organic and/or Utz Certified accreditation. Of these strategies, the sale of cherry results not only in a 34% price premium but entails significantly less work and costs for the growers. Where smallholder coffee farmers are unable to sell cherry to wet mills, standardised processing systems must be introduced at the village level. In this instance price incentives would be best achieved through the formation of collaborative marketing groups that transact directly with traders and exporters. This would also be the best arrangement for pursuing accreditation under the Fair Trade and Organic markets.

Agriculture offers women a way to earn income to help their families.

In July 2008 the Coffee Industry Corporation reported an **oribius weevil epidemic** on coffee in Chimbu province. Should such an epidemic spread to other districts and provinces, it has the potential to severely impact the PNG coffee industry. Research to stem the weevil's migration and find ways to combat the pest is underway. The project team found low levels of the weevil and damage from sucking bugs. It suggested that the 'outbreak' was likely to have been a combination of greater identification stemming from enhanced public awareness, resulting in greater recognition, and generally elevated pest populations due to atypical climatic patterns (especially a wetter 'dry' season). Permanent, structured monitoring to track pest populations and damage levels on coffee in Chimbu and neighbouring provinces for the 2008–09 coffee seasons was recommended. If damaging pest levels do not occur in 2009, no further action beyond low-level permanent surveillance would be needed.

The incidence of **coffee green scales** (CGS), which can cause up to 10% loss in coffee yields, was determined via major surveys in Eastern Highlands province in 2006–07. Subsequent analysis of this study showed that CGS infestations were highest at 1,500 m altitude—both above and below this, infestations were much lower. Both human-mediated and natural pathways appear to be involved in CGS spread. Nurseries grow and supply seedlings that happen to be infested with CGS, and simple sanitation could make clean plants available to farmers. However, another common route is via infested farms where farmers propagate their own seedlings. With the natural spread possibly being mediated

via exotic invasive ants, both ecological and anthropogenic issues need to be resolved, and a scoping study has addressed farmer practices, awareness and extension. An additional study determined that excluding ants reduces CGS infestation rates over time.

A project is seeking to **improve extension delivery** through greater commercial sector engagement with smallholders, and to develop effective land-use agreements between the commercial sector and customary landowners. A core component of the project is to implement innovative payment systems for productivity-enhancing inputs that accommodate the socio-cultural context of smallholder production. For example, work at Bialla with **oil palm** has introduced a mobile card payment scheme that guarantees payment of family and hired labour for work on smallholder oil palm blocks. The payment initiative was developed and trialled successfully in an earlier ACIAR project. In addition, a draft Clan Land Usage Agreement has been developed after extensive consultation with the Oil Palm Industry Corporation, customary landowners and migrant smallholders growing oil palm on customary land in Bialla, Hoskins and Popondetta.

Symptoms of magnesium (Mg) deficiency are widespread on volcanic ash soils where oil palm is grown in West New Britain. However, application of soluble Mg fertilisers such as kieserite had failed to significantly increase yields. Field trials were conducted to gain a better understanding of this problem. The effectiveness of Mg fertilisers with different solubility and application methods were tested. As potassium (K) is known to compete with Mg uptake, the project was broadened to include research on K. Valuable information has been obtained from this research on Mg and K dynamics in soil, spatial distribution of root activity and uptake of these nutrients under different soils. This information has been used by the plantation companies to reassess fertiliser recommendations to overcome nutrient deficiencies and increase the productivity of oil palm.

Subprogram 4: New livelihoods from smallholder fisheries, aquaculture and forestry

Efforts are underway to **improve fingerling supply and fish nutrition** for smallholder farms adopting inland aquaculture in PNG. A total of 1,460 smallholder farmers have received training in various aspects of pond culture of the commonly used tilapia and carp. A number of small feed mills have been installed and are operating in the Eastern Highlands and Morobe provinces. There is good potential to use these mini-mills for poultry feeds as well as fish feeds. A rehabilitation program based on fish farming has been initiated for prisoners at Bihute Prison. The program was well regarded and there is acknowledged potential for the scheme to be used as a model for the PNG prison system.

Everywhere in PNG **tree-growing and management of trees** are incorporated into both traditional and modern farming systems. Commercial tree-growing appears a good prospect for landowners with limited income-generation alternatives. A project is working to encourage the adoption of commercial-scale high-value tree growing in PNG, developed through a relationship fostered between landowners and selected business partners. Fieldwork in three project pilot study regions has found that the land-use systems, and landowner experience of commercial tree growing, vary significantly between the three regions. Some landowners in the North Coast and Golgol Valley regions around Madang have participated in growing *Acacia mangium* for export; a smaller number in the Markham and Ramu valleys are at an earlier stage of growing trees with commercial potential; in Western province the only landowners that have engaged in commercial tree growing are those participating in rubber cultivation in various forms of partnership facilitated by North Fly Rubber Ltd. Preliminary results from Western province fieldwork have assisted the project team to develop a draft assessment of possible commercial tree-growing activities and associated business models.

Past ACIAR research established the feasibility of **domesticating and commercialising the canarium nut** in PNG. The nut is currently used for food but supply falls well below demand. A new project is now building on those findings, seeking to ensure sufficient supply of *Canarium indicum* and establish a reliable marketing network. The project is working to select cultivars that produce nuts regularly and fruit heavily to close the demand gap. Robust nursery propagation techniques using low-cost systems suitable for community and village uptake are being established to help create a more regular supply of high-quality fresh nuts as a basis for development of a marketing network.

The project has made substantial progress in both vegetative propagation and genetic resource exploration/characterisation. A breakthrough was achieved in vegetative propagation of juvenile material, with success rates now above 90% for the best treatment combinations. Success is attributed largely to use of higher quality stock plants, and research on stock-plant management is continuing. Marcotting (air-layering) of superior adult canarium trees is being used as a way to capture their genotypes for future multiplication. Although canarium is difficult to marcot, success rates have been sufficiently high to permit capture of the genotypes of superior adult trees. Another project is developing protocols for the processing and storage of canarium nuts. The project participants, with experience in the macadamia industry, have already developed a modified macadamia nut cracker that is effective for canarium and is attracting interest within the PNG industry.

Fuelwood is a crucial but undeveloped component of the domestic economy of PNG. **Fuelwood plantations** could directly enhance smallholder income and provide a pathway for rehabilitating grasslands. A project is establishing a national fuelwood economy based on woodlots and agroforestry systems. Project activities in 2008–09 focused principally on fieldwork in the three project pilot study regions in Morobe, Madang and Western provinces to investigate landowner attitudes to tree growing as part of their farming systems. Development of village-level nursery systems and the delivery to landowners of seedlings of commercial species raised in other nurseries is underway with landowners in the Markham and Ramu valleys.

PNG enjoys some significant competitive advantages in relation to the production of timber; however, a challenge remains in the management of secondary forests. Smallholder agroforestry plantings and community-based management offer significant potential to address this challenge. This industry could become a much larger contributor to the national economy than the current log export industry if coupled with a significant domestic processing industry. A project is providing the foundation for a more extensive and more sophisticated **domestic timber processing industry** in PNG. It is exploring the development of various products and designs based on solid wood and veneers, examining the potential for value chains to integrate advanced processing with production of timber in smallholder agroforestry systems and community-managed secondary forests, and enhancing capacity in timber processing training, education and R&D.

Subprogram 5: Agricultural biosecurity and sustainable management of forestry and fisheries resources

There is an ongoing problem of **poor reporting of animal diseases** in PNG, where veterinary or allied animal health resources are limited, livestock production is often at smallholder or subsistence levels, and infrastructure is limited. A project is developing systems that are sustainable, are simple to operate, provide a basic set of animal population data, and are capable of estimating the impacts of disease on the production system. Templates of two reporting tools were developed for pigs and chickens, which are the most prolific livestock kept in the project sites and underpin the village livestock food and income streams. These templates, developed and revised after

Pyrethrum seedlings are distributed to families in the highlands, where the industry is being re-commercialised.

initial use at the project sites, enable village livestock owners to record information on chicken and pig populations, reproductive rates and end uses of the livestock, including sale at market or family food production. The templates also record syndromes of skin, intestinal, respiratory and nervous diseases.

A concern for crops in PNG is **Ramu stunt disease of sugarcane**, for which the island sugarcane plant hopper *Eumetopina flavipes* is the only known vector. Fortunately, this disease does not occur in Australia, but virus-free populations of this plant hopper occur in the Torres Strait Islands (TSI) and northern peninsula area (NPA) of Queensland. A research team has worked to develop an integrated management program for *E. flavipes* in commercial sugarcane plantations at Ramu Sugar Ltd (where Ramu stunt disease continues to impact upon production) and to gain a detailed understanding of the population ecology of *E. flavipes* populations throughout PNG and TSI/NPA. There are now recommendations on pre-emptive management of *E. flavipes* in TSI/NPA via cultivation techniques such as simultaneous tip pruning. However, in PNG, due to the widespread distribution and persistence of the pest across multiple wild and cultivated hosts, management effort should be more focused on dealing with Ramu stunt disease—via planting new, resistant varieties and vigilant surveillance for new disease outbreaks.

Cocoa pod borer (CPB) is having a devastating impact on the livelihoods of smallholder cocoa growers in East New Britain, with almost 90% of production lost in some areas. A project team undertook a **social and economic impact assessment of CPB** in May 2009 as part of developing a strategy to address the problem. Controlling CPB requires farmers to raise inputs of labour to undertake CPB management techniques such as weekly harvesting (every mature pod), centralised pod breaking and pod burial. High levels of block management (pruning, shade control and weed control) are also needed. This is the opposite of the usual low labour input system of production (the foraging strategy) employed by PNG farmers. The project is working with commercial sector partners to deliver new forms of extension designed to mobilise labour for effective control of CPB. Promising results from the monitoring program are emerging, with some farmers switching to a high-input system and effectively controlling CPB.

The **log export industry** in PNG contributed K476 million[1] to the national economy in 2005, but its current level of harvesting is unsustainable. Accessible primary forest is likely to be logged out in the next 15 years. Properly managed, however, PNG's forest resources could continue to make a major, sustainable contribution to

[1] K = kina (PNG currency)

Potatoes (cultivar Sequoia) on sale in the Mt Hagen market. [Photo: R.F. De Boer]

the PNG economy while maintaining many of the qualities that PNG society values from its forests. ACIAR's forestry strategy for PNG, developed in collaboration with PNG colleagues, is designed to promote a positive vision for PNG forestry. This project, a key element of the strategy, aims to improve the contribution that PNG's secondary forests make to both its national and local economies. Collated, checked and cleaned data has been collected from 120 permanent sample plots measured repeatedly between 1992 and 2008. The improved database is now complete and ready for analysis as part of the development of new growth models for cut-over forest in PNG.

Research continued in four provinces in PNG to investigate the efficacy of various **fruit fly management strategies**. These have been completed and the results are now being collated for analysis. The results of these trials will provide useful information regarding the effectiveness of management strategies such as protein baiting, male annihilation technique, fruit bagging and local pesticide use in each location and crop. An economic analysis based on a single farm case study is determining if the level of control achieved from the management strategies provides benefits that outweigh the cost of the technologies themselves. This will inform recommendations to further develop the supply chain for these technologies, which are currently not commercially available.

Other projects

The ACIAR Postgraduate Scholarship Scheme for PNG University of Technology (Unitech) commenced in 2005 and is now into Stage 3 of support; currently, there are six ACIAR scholars undertaking postgraduate diploma training in 2009, three ACIAR scholars have been accepted for MSc training in 2010 and three more scholars for PhD training in 2010. Students' research projects have been linked with active ACIAR projects in PNG.

The smallholder broiler chicken industry produces about six million birds per year with a value of A$54 million. Reducing feed costs, the main constraint to profitability, is the subject of a project investigating best-bet feeding options for **feeding broiler chickens** in highland and lowland regions of PNG. Evaluations of options were conducted at non-government organisation (NGO) demonstration sites using a concentrate system developed by the National Agricultural Research Institute (NARI). The diets found to be the most suitable for growing meat birds were; 50% sweetpotato + 50% low-energy concentrate; 70% sweetpotato + 30% low-energy concentrate; and 50% cassava + 50% high-energy concentrate. The three NGO partners compared the diets in broiler grow-out trials in the highlands, the lowlands and in remote Western province, obtaining such promising results that each has now selected 20 village farmers to test their respective best performing concentrate feeding system against the current broiler feeding system that uses commercial feed. The project also established that there are good prospects for a mini-mill to produce chicken feeds based on local ingredients.

An ACIAR project to **improve yield and economic viability of peanut production** in PNG and Australia has documented the

critical role of peanuts in PNG farming systems. High-yielding peanut germplasm lines from the International Crop Research Institute for the Semi-Arid Tropics were introduced and evaluated in multi-location trials in PNG, leading to the identification of promising varieties with potential to yield 50–100% greater than the local varieties. These new varieties are being transferred, with associated management technologies, to smallholders. This is enhancing the markets for, and marketability of, new peanut varieties in PNG. The project also assisted farmers affected during the Oro province natural disaster, supplying 0.6 tonnes (t) of seed for the restoration program.

Fourteen 'seed village' trials conducted in the Upper and Lower Markham Valley regions, Eastern Highlands province, showed that productivity of dryland peanut can be increased from the existing 1t/ha to 4t/ha by using local or new varieties and adopting a set of improved practices. The research outcomes have led to publication of a best management practice manual for growing peanuts in PNG, published as ACIAR monograph No. 134.

Pyrethrum—PNG's resurgent industry

When the pyrethrum daisy plant was introduced into PNG in the late 1950s it formed a major highland industry—employing as many as 80,000 people by the late 1980s. It is the source of pyrethrum, an in-demand insecticide with benign properties that make it desirable for use in insect sprays, pet shampoos and home gardening products. The PNG growers sold their local product to a processing factory and the factory owners handled the marketing. Closure of this factory ended the local market and curtailed the industry.

Now a Tasmanian pesticide manufacturer has come to the aid of the women in PNG whose livelihoods were affected by the closure of the industry. Botanical Resources Australia (BRA) has offered to buy the PNG crop and help recommercialise the industry. Despite conducting research in Australia, BRA had little experience of research for development, and certainly not in PNG. ACIAR was well placed to bridge the gap—a project was developed and commenced in 2007. To date, BRA has helped improve the Enga province processing factory and refurbished its laboratory.

Better planting materials and improved agronomic practices, along with research into the adoption of improved production and plant physiological factors, are essential requisites for the project's success. Janet Yando, who has been appointed Extension and Promotion Officer for the project, speaks of her involvement:

'I mostly work with local farmers, particularly pyrethrum growers in several communities. My task is to encourage farmers, mostly women and youth groups, to increase production. I conduct informal training sessions on their farm sites to show them better ways of planting the crop, better management practices, and the right time to pick.

'But 45% of my time each week is spent at the resource centre, working on clonal selection plots, density trial plots and other tasks. I work with the agronomist from NARI to improve planting materials for the farmers. Then I pass on information on the results of our work to the farmers during the field visits.'

Meanwhile, BRA has hosted a visit of five key PNG officers to its Tasmanian factory. Mr Brian Chung, manager of product development at BRA, states that while the company's involvement in a development aid project was somewhat unexpected, BRA has now found its stride. 'It became obvious we had the skills and technology to make substantial improvements,' he says. 'So we intend to be in for the long run.'

Pacific island countries

AOP budgeted expenditure in 2008–09	$2,988,579
Actual expenditure in 2008–09	$3,159,410
Expenditure in 2007–08	$2,793,743
Expenditure in 2006–07	$3,143,726

Key performance indicators	Performance 2008–09
Research program implemented that underpins emerging high-value forestry plantation programs for teak, whitewood and sandalwood	Activities in Vanuatu and Solomon Islands are making good progress towards the definition of silvicultural regimes for whitewood and teak that are compatible with traditional agricultural and agroforestry practices.
Projects developing new fruit crop opportunities for Tonga and new vegetable opportunities for Solomon Islands implemented	In Tonga activities have established which tropical fruits are already grown and marketed to guide research and training programs to support development of suitable new crop varieties. In Solomon Islands seeds of adapted cultivars of exotic vegetable species have been introduced and are being spread among farmers through an innovative seed-exchange scheme.
Improvements in aquaculture-based livelihoods investigated through a mini-project approach in at least three countries	Eighteen mini-projects have been designed and approved by ACIAR. Eleven of these, involving four Pacific island countries (Solomon Islands, Vanuatu, Fiji and Tonga) and PNG, have commenced.
ACIAR–University of the South Pacific scholarship scheme implemented with at least five students placed within active ACIAR projects	An additional eight scholarships were awarded, bringing the total number to 16 since the project commenced in 2008.
Preliminary policy environment implications ready for adoption from an assessment of all ACIAR projects in the Pacific	The capacity of Pacific extension staff and organisations to undertake participatory research and extension associated with ACIAR projects and to work with governments to design appropriate interventions and policy changes was assessed. Training and participatory needs assessment activities have been conducted in Palau, Fiji, Tonga, Western Samoa, Vanuatu and the Cook Islands, and the results presented at an Extension Summit in Fiji in May 2009.
At least 40% of new projects designed to have significant farmer or policymaker impacts within 5 years of completion	Four of the six new projects implemented in the Pacific islands during 2008–09 are designed to have significant farmer or policymaker impacts within 5 years of completion.

Position

ACIAR's position in the Pacific island countries (PICs) supports research, capacity building and the adoption of successful past projects to assist with reducing unemployment and improving food security through economic growth. Agriculture, forestry and fisheries comprise the majority of livelihoods for many people living in the Pacific. The dependence on these sectors creates an opportunity to increase household income through lifting productivity of, and diversification from, new crops, products and value-adding, together with the development of sustainable forestry and fisheries management systems and the strengthening of marketing and biosecurity.

These research thrusts support the broader AusAID Pacific Regional Aid Strategy 2004–09, which identifies broad-based economic growth as a key theme. The centrality of agriculture in the economies of the Pacific islands presents opportunities to use increased production to achieve economic growth. Creating an environment that supports this growth, and addresses the vulnerability of small island states to changing economic and environmental situations, also requires a more effective implementation of policy.

ACIAR research focuses activities through three subprograms: more productive and diverse farming systems for householders, sustainable natural resource management and farming systems economics, and marketing and biosecurity. Priorities in 2008–09 included the identification and management of constraints to productivity in high-value crops, sustainable production of oceanic and inshore fisheries, and development of emerging forestry plantation opportunities. Trade liberalisation, policy and constraints to new market opportunities were assessed across the region.

Achievements

Subprogram 1: Improving household incomes and food security through more productive and diverse farming systems

The Asian honeybee (*Apis cerana*) has spread in Solomon Islands since 2002, impacting on the European honeybee (*A. mellifera*), which is kept for honey production. Since Asian honeybees were first detected, the number of hived European honeybees has declined and feral European honeybees have virtually disappeared on some islands—on Guadalcanal Island they have disappeared completely. Project work is underway to develop a means of suppressing Asian honeybee densities in Solomon Islands, based on the assumption that fewer Asian honeybees will improve the competitiveness of European honeybees. During the past year a trial was conducted on Savo Island to determine whether the broad-spectrum insecticide fipronil would suppress Asian honeybees. Fresh sugar syrup containing a concentrate of fipronil was used to attract the bees, and colonies under observation that showed clear signs of poisoning were dead within 14 days. No detrimental side effects were observed from using fipronil, and Asian honeybees have only slowly recolonised the site.

The project work has detected the serious microsporidian pathogen *Nosema ceranae*, which has recently been implicated in severe mortality of European honeybees in Europe and USA. The decline of European honeybees on Solomon Islands was thought to have resulted from poor management and from the Asian honeybees being more aggressive. However, high levels of the *N. ceranae* pathogen were found in Asian honeybees on Savo Island, which is free of European honeybees, indicating that the Asian honeybees may have introduced the pathogen and it may now be playing

Mr Les Baxter, ACIAR Research Program Manager, Horticulture, with a nursery officer in Fiji discussing improved planting material.

an important role in the decline of European honeybees. The reproductive behaviour of the varroa mite hosted by the newly arrived Asian honeybees (the Java strain of *Varroa jacobsoni*) was also monitored. This task assumed greater urgency following the discovery in May 2008 that the same mite had developed a newfound ability to reproduce on European honeybees in PNG. Monitoring confirmed that the mite in Solomon Islands still lacks the ability to reproduce on European honeybees.

In both Fiji and Australia a significant agricultural export, **ginger, is being threatened by the build-up of soil-borne diseases**. The main diseases found are *Pythium* in Fiji and *Fusarium* in Australia. Production, particularly in Fiji, is declining and affecting the quality of rhizomes, which production systems rely on for new plants. Evidence suggests that increasing the microbial diversity found in root zones of plants can ameliorate soil-borne pathogen damage. The project is using this knowledge to test and develop recommendations for appropriate management strategies to control diseases in both countries. The project has confirmed that *Pythium myriotylum* is highly pathogenic on ginger in Fiji, and has established that disease epidemics occur when soils become saturated after extended periods of high rainfall and relatively high soil temperatures. In addition, other species of *Pythium* have been isolated from ginger rhizomes in both Fiji and Australia. Investigating suitable control measures for *Pythium* rhizome rot has been problematic in the past due to the discontinuous distribution of the fungus in the soil, the development of disease 'hot spots' and the particular epidemiological features of the disease. Trials are underway using a prepared inoculum and controlled watering regime to replicate the disease spread and allow an understanding of outbreak patterns.

The **diamondback moth is the leading pest of brassica crops** in the Pacific islands. Both large and smallholder farmers grow brassicas, mainly head cabbage, Chinese cabbage and watercress. With production increasing in recent years, opportunities for the moth to spread have expanded. The use of insecticides is the main form of control. IPM approaches to the diamondback moth have been used elsewhere in the world, limiting insecticide use while maintaining control. A project is developing a locally relevant program for Fiji and Samoa, based on more comprehensive knowledge of the moth's behaviour in each country. Good progress has been made towards demonstrating the effectiveness of IPM approaches to brassica pests in both countries. Trials of IPM were conducted at Nu'u crop research station in Samoa in 2008–09. These experiments confirm that the IPM strategy promotes natural enemy activity and can maintain pest numbers below

threshold levels. The trials have found that the number of applications required of a biological pesticide based on *Bacillus thuringiensis* are far fewer than the conventional insecticide applications typically applied.

Two ACIAR-funded projects have worked in parallel with AusAID to develop **sensitive tests to detect taro viruses**. A follow-up study of a taro production system is determining the yield gains from using virus-free planting material, and is also undertaking a cost–benefit analysis on the economics of using such material. The work has focused on Dasheen mosaic virus (DsMV) that commonly affects taro throughout the Pacific region. Despite its widespread occurrence, there have been no studies carried out to determine the impact of this virus on yield of taro in the Pacific. The research team has identified taro plants infected with DsMV and also non-infected plants in both Fiji and Samoa through a series of exhaustive tests. Aphid-proof screenhouses have been erected in both countries and plants are now being grown to determine the relative performance of infected versus non-infected plants.

Many people in Solomon Islands and PNG do not receive enough dietary vitamin A, which is vital in boosting immunity to disease. The orange-fleshed sweetpotato (OFSP) is a nutritionally enhanced staple containing among the highest concentrations of beta-carotene (the major pro-vitamin A carotenoid) of any food—as little as 100 g/day can prevent vitamin A deficiency. In Solomon Islands and PNG a project is **surveying promising coloured sweetpotato cultivars for carotenoids**, in particular beta-carotene. The screening phase of the project, focusing on Solomon Islands, is now complete, with 77 orange- and yellow-fleshed sweetpotato varieties analysed for tuber levels of beta-carotene. Eighteen local varieties exceeded 100 mg/kg beta-carotene (dry weight basis), with seven of these recording over 200 mg/kg, an excellent level.

The most suitable Solomon Islands OFSP varieties identified in the survey have been included in the improved root crops program of the Kastom Gaden Association (KGA), with bulking and distribution occurring at several regional centres. Local knowledge of the health benefits of OFSP varieties was scarce, and an awareness program has led to 22 nutrition workshops now being conducted in Makira, Ulawa, Malaita (Solomon Islands) and around Lae, Marobe province (PNG). The program has now been expanded to include other local nutritious foods, including high-carotenoid bananas, legumes and leafy vegetables.

A feasibility study in 2006 found significant scope to **increase production in the Tongan fruit industry** and thus increase household income levels, with opportunities for import replacement, growth of the existing domestic market and, in the longer term, Pacific inter-island trade and export to other regional markets. A project arising from the study is seeking to increase the production, productivity and technical capacity of the Tongan tropical fruits industry with an emphasis on the local market. In March 2009 Tongan project members embarked on a study tour to northern Queensland. The aim of the tour was to give them greater familiarity with the commercial fruit industry, in particular the fruits themselves, nursery practices and nursery enterprises. In Tonga two nurseries have been identified for use by the project—one for seedling production and one for trials and demonstration plots—and both have

Sweetpotato for sale in the market in Solomon Islands, where ACIAR-funded research is improving production through pathogen-tested planting materials.

undergone significant renovation. Of 35 fruit species identified, 18 were selected to provide propagating material. Seeds of 12 different species were also imported from northern Queensland for establishment, with the seedling nursery now holding 40 fruit species with a stock of around 10,000 seedlings and plants.

Stakeholders in a project to **improve plant protection in Solomon Islands** have worked over the past 3 years to install a crop protection capability in the country. Research continues on the seasonal abundance, life cycle and taxonomic status of *Nisotra*, a chrysomelid beetle pest of *Abelmoschus manihot*, an important green leafy vegetable. A local derris variety has been identified as a potent spray against the beetle and, from experience in PNG, is likely to be equally effective against *Amrasca*, a jassid pest. Derris and also neem (a natural pesticide extracted from the neem tree) are being multiplied and distributed.

Lead farmers continue to show others how to employ IPM to control Alomae (a lethal virus disease of taro) by understanding its spread. Work to identify natural enemies of the diamondback moth of head cabbage has been unsuccessful, but there is renewed enthusiasm among watercress growers at Mamara, near Honiara, to control the moth and other pests, and to obtain help with marketing.

Subprogram 2: Sustainable use and management of forestry and fishery resources

The bêche-de-mer (sea cucumber) fishery is potentially a multimillion-dollar industry in Solomon Islands; however, **persistent overfishing has put the fishery in real danger of collapse**. A project set out to work with coastal communities in Solomon Islands to assist them to manage their sea cucumber resources sustainably while gaining better returns for their bêche-de-mer product. But 6 months after the project began the Solomon Islands Government implemented a national ban on the collection and export of bêche-de-mer. The project was re-cast in consultation with stakeholders to increase the emphasis on sustainable management of the sea cucumber and to work with communities to assist in dealing with the sudden inability to use this important resource.

The project team has worked with communities in Kia district and Jorio to establish community-based management plans for sea cucumber. At the request of the community, the plans were broadened to cover all marine resources. As a result, in May 2008 the Kia community established a marine managed area covering approximately 450 km^2. This work formed the basis for a similar management plan for an area of 170 km^2 of the Jorio region, which was implemented from September 2008. This project offers a critical case study in a much broader re-analysis of approaches to small-scale fishery management in the developing world.

The focus of another project is **culture of the winged pearl oyster** (*Pteria penguin*), in support of the cultured pearl industry in Tonga. The first hatchery run in Tonga in May 2008 produced a large quantity of spat (~60,000). The spawning induction and larval culture methods used were based on those developed for other species of pearl oyster in an earlier project. However, relatively cold water temperature and problems with live microalgae culture (food for the larvae) at the facility in Tonga led to the use of a heat-exchange system, to maintain good water temperature in larval culture tanks, and commercially available microalgae concentrates, which eliminates the need for live micro-algae culture. This has major potential benefits for hatchery culture of pearl oysters (and other invertebrates) in the region, including reduced reliance on dedicated hatchery infrastructure, reduced hatchery costs and elimination of the need for specialised algae-culture skills.

Prawn farming is currently one of the most important sectors in fisheries in Fiji; however, **expansion of prawn farming in Fiji** depends on availability of quality prawn postlarvae, the

supply of which is currently the main bottleneck to growth. A current project seeks to compare the relative productivity of the prawn strain currently farmed in Fiji against a set of selected high-performing stocks available in Asia, and to develop low-cost feeds specifically for the local species. Postlarvae stock of three high-performing culture lines from Indonesia, Malaysia and Vietnam were introduced to Fiji, following 21 days' quarantine, to stock broodstock ponds at Naduruloulou Research Station. In addition, feed ingredients have been sampled at Viti Levu and taken to the Queensland Primary Industries and Fisheries laboratory in Brisbane for analysis.

A forestry project aims to **reduce the risk of serious damage by exotic pests** to the valuable timber resources of Fiji, Vanuatu and Australia by establishing efficient detection systems for target pests in high hazard sites. Simple and robust technologies involving static trapping systems and sentinel plantings are being developed. In particular, the project aims to minimise losses in the valuable plantations of Fiji and the emerging plantation industry of Vanuatu. This is part of a 'neighbourhood watch' approach to incursion management that will benefit all regional countries, including Australia. The project has already had a potentially significant impact; the Asian ambrosia beetle (*Xylosandrus crassiusculus*), a pest of potential economic significance to Fiji's mahogany plantations and not previously known in Fiji, was detected during static trapping. The Fiji Forestry Department has shown its commitment by allocating its own funds to continue surveillance work, and has already detected and controlled an incursion of Semanotus beetle.

An ACIAR project to **improve the value and marketability of coconut wood** has completed resource characterisation assessments on material sampled from a range of Fijian and Samoan sites. Recovery data and drying information added to the existing information on cocowood sawn recovery. In addition to sawn boards, full cross-sectional discs were harvested from sampled logs to provide test specimens for grain deviation and grain angle measurements. It was discovered that cocowood has three helices, offset to each other, that form a strong interlocked structural cylinder.

Cocowood has a reputation for high silica content, often given as the reason for rapid blunting of tool edges during processing. Studies found that the abrasiveness is more likely attributed to the combination of high levels of a range of mineral compounds (total mineral content is 2–3%) rather than specifically due to silica. As well, samples covering the range of density found in cocowood were tested for resistance to termites at a northern Queensland site. It was found that, although resistance increases with increasing density, all densities were susceptible to termites.

The government of Vanuatu intends to greatly expand its plantation estate over the next 18 years, and there is **international interest in a whitewood (*Endospermum medullosum*) plantation industry**. A significant amount of genetic improvement and propagation research of whitewood has already been carried out, but current plantation practices are poor. A project is developing comprehensive silvicultural prescriptions for community-based plantation forestry with whitewood in Vanuatu. Trial plots of whitewood monocultures have been established to deal with issues of weed control, plantation management and spacing–thinning practices. These have been augmented with other trials focusing on agroforestry combinations and mixtures involving other tree species.

***Canarium indicum* nuts** are marketable products with great potential to improve the livelihoods of rural households in the South Pacific. At the moment the canarium nut industry is small but there is strong consumer demand and acceptance of the product in PNG, Solomon Islands and Vanuatu, offering the potential for expansion of the domestic markets and development of an export market. A major constraint to increased commercialisation of the industry is poor quality of the nuts due to

inferior postharvest handling and processing techniques. A project aims to develop techniques that optimise quality while being appropriate for small-scale agriculture. Researchers have determined that placing unshelled nuts in water enables the full-kernelled ones that sink to be separated from those with little inside that float. This process is now recommended as a protocol at point of purchase. Floaters will be of lower value and can either be discarded or downgraded. Drying nuts at 40°C increased the percentage of whole kernels to around 80%. This is a very significant finding as canarium nuts tend to break into small fragments and these are difficult to market. A nutcracker developed for macadamias has been modified for use with canarium, creating strong interest among growers, with many expressing interest in purchasing one.

A significant **community-based teak plantation industry** is now emerging in Solomon Islands. Teak is a high-value timber with a strong market demand that is likely to escalate as the supply of timber from natural forests dwindles. A project aims to develop agroforestry systems, suitable for smallholders, based on wider final-crop spacing of teak or rosewood, and row interplanting with tree species that could be harvested as a commercial crop at an earlier age. The project is also investigating high-value products from small-sized logs of teak, rosewood and interplanted species. The initial phase of the project has successfully finished, with demonstration trials established at three Rural Training Centres (RTCs). Work has begun on developing curricular materials for use by the RTCs at the curriculum development unit of the Solomon Islands College of Higher Education. This work is being partially funded through the European Union and is a close collaboration with a similar project introducing smallholder timber plantings into the state school system.

While a **marked increase in sandalwood planting** has occurred in Vanuatu over the past 5 years, there are a number of technical and socioeconomic factors that limit the expansion of this industry. A project aims to address the knowledge and resource gaps that currently constrain the industry's development. It is investigating the economic prospects for a sandalwood planting industry in Vanuatu, analysing financing and industry partnership models and marketing options. The project's main output is a prospectus outlining investment potential for sandalwood in Vanuatu.

Subprogram 3: Farming systems economics, marketing and biosecurity

Analysts studying **an established tuna cannery** in Madang province, PNG, and a proposed cannery in Solomon Islands have used modelling to measure the range of benefits and costs that the host country could expect to flow from a domestic tuna cannery. The model also measures the net benefit to a foreign firm investing in a cannery under a range of possible financial arrangements, and can be used as a tool in negotiating any tax or similar concessions requested by the firm. Partner-country staff members have been fully involved in the survey at the Madang cannery and the subsequent development of the model, and they are now able to apply their knowledge to new proposals as they come forward.

ACIAR has commissioned the University of the South Pacific (USP) to manage and administer a **postgraduate scholarship scheme**, initially for 3 years, focusing on those wishing to pursue further studies in agriculture, forestry, fisheries and agricultural economics. In 2008 eight postgraduate students were selected and received ACIAR–USP scholarships for postgraduate diploma and Masters programs. Five students are based in Lacuala Campus, Fiji, at the Marine Studies Program and the other three students at the School of Agriculture in Alafua Campus, Samoa.

Pacific flower industry set to bloom

Flower cultivation (floriculture) is an infant industry in the Pacific. By contrast, in some Asian and African countries it is big business, and can give smallholders a profitable cash enterprise.

Selling cut flowers at a local market in Honiara, Solomon Islands

The opportunity for **Pacific smallholders to embrace floriculture** has led to an ACIAR scoping study to examine the potential for the industry in Fiji and PNG. Flowers such as heliconias, anthuriums, ornamental ginger and orchids thrive in Pacific countries and make spectacular floral displays. But until recently little regard has been given to their commercial potential. The ACIAR study considered opportunities for small producers to capitalise on this resource.

A major part of the study focused on the rapid expansion of the local non-tourist flower market in Fiji, which followed the establishment of wholesale markets in Nadi (1999) and Suva (2001). Their establishment has given small florists and informal flower-arranging businesses a consistent supply of high-quality inexpensive flowers. The result has been an unprecedented growth in demand. The traditional main market is for weddings and funerals, but a new outlet has emerged for cut flowers in homes and the workplace. The survey highlighted that the future of the industry lay in encouraging these local markets. Investigations into the potential for export found that Fiji had no comparative advantage, especially in relation to the industry in South-East Asia.

The study looked at the prospects for developing other floral lines for the local Fijian market. Guzmanias, ornamental members of the pineapple family and known in the Australian industry as bromeliads, were recommended. As a result, more than 16,000 improved variety plants were imported from Holland in 2008 and distributed to growers. A horticulturist from Darwin who pioneered the Northern Territory's multimillion-dollar cut flower industry back in the 1980s worked with women growers in Fiji to help them improve their business practices and bring elements of quality and value to growing and marketing. The study attracted interest from seven other Pacific countries, whose representatives, with the support of the Technical Centre for Agricultural and Rural Cooperation, toured floriculture enterprises in Fiji. They saw much to encourage them and learnt the lessons of success and failure experienced by the Fiji industry.

South-East Asia

Ibu Supriyani is a local extension worker with the PPL agency in Aceh, Indonesia. Following the devastating 2004 tsunami, which left agricultural lands covered in debris, Supriyani has worked with women's groups to introduce composting, small-scale poultry production and natural pest management techniques, some of which she has learnt through her involvement with an ACIAR-funded post-tsunami, rehabilitation project.

Financial year	Regional expenditure (A$)	Percentage of total project expenditure	Commission target as percentage of expenditure
2008–09	24,507,412	56.6%	> 45%
2007–08	22,995,604	60.8%	> 45%
2006–07	21,586,153	54.8%	> 45%

Indonesia

AOP budgeted expenditure in 2008–09	$10,923,484
Actual expenditure in 2008–09	$11,497,371
Expenditure in 2007–08	$10,636,082
Expenditure in 2006–07	$9,673,583

Key performance indicators	Performance 2008–09
A new R&D strategy for improvement in productivity and competitiveness of the Indonesian tropical fruit industry agreed and implemented	Following the development of an industry strategic plan, ACIAR implemented three projects that address key fruit industry issues including improved market access and quality, improved policies for competitive supply chains, and building the capacity of the eastern Indonesia industry.
A joint Indonesian–Australian major agricultural R&D initiative in Papua, Indonesia, designed and implemented	A new project, 'Improvement and sustainability of sweetpotato–pig production systems to support livelihoods in highland Papua and West Papua, Indonesia', designed through a series of workshops and consultations, commenced in March 2009.
Initial outputs achieved of the adaptive research component of the Smallholder Agribusiness Development Initiative used by participants in the agribusiness value chain to enhance profitability	Twenty adaptive R&D projects were funded to either work in existing value chains or promote new chains, with outputs now being used including: better timing of irrigation, resulting in 15% reduction in water usage in irrigated rice fields; selected cocoa clonal materials being used in more than 200 farm nurseries in Sulawesi, Indonesia's largest peanut company, developing a seed supply scheme that will be expanded to 18,000 farmers; and forage legumes able to produce 4,000 kg dry matter/ha in rotation with maize in Nusa Tenggara Timur to feed livestock during the late dry season in use.
Development of improved approaches to technology assessment facilitates knowledge exchange between R&D and extension providers in eastern Indonesia	Pilot roll-out projects were implemented for developing improved approaches to technology assessment and knowledge exchange, with workshops held with provincial teams to evaluate and develop the approach, a study conducted to improve the effectiveness of communication through extension media, and workshops held with Provincial Technology Commissions to strengthen research and extension linkages.
Improvements to Indonesia's veterinary services system, policy and operations commenced through development, endorsement and piloting of Indovetplan; and improvements to endemic disease control programs	Four projects have contributed to the Indovetplan: a new surveillance protocol for foot-and-mouth disease; training courses for 15 veterinarians in avian influenza risk analysis and control; a surveillance program for rabies control in Bali and three training workshops for zoonotic disease control in eastern Indonesia; and the creation of a government–donor–industry forum for poultry biosecurity.

Key performance indicators	Performance 2008–09
Redevelopment of Ujung Batee Regional Brackishwater Aquaculture Development Centre, providing effective delivery of technical services to Aceh farmers	The Centre has been rebuilt and revitalised under the Australia Indonesia Partnership, and opened by the Australian Prime Minister in 2008, and is the primary source of technical services for the aquaculture industry in Aceh.
Aquaculture planning tools adopted by relevant planning agencies in South Sulawesi	Simple aquaculture planning tools developed under past projects are widely seen by stakeholder agencies as having significant potential to underpin sustainable growth of coastal aquaculture in Indonesia.
At least 40% of new projects designed with potential for significant farmer or policymaker impacts within 5 years of completion	Five of six projects commenced in Indonesia in 2008–09 are designed to have significant farmer impact within 5 years of completion.

Position

Indonesia is one of Australia's most important and strategic development assistance recipients, and ACIAR's largest country partner. An estimated half of Indonesia's population of 226 million live in poverty, with these people heavily concentrated among those with little or no formal education. Many live in eastern Indonesia and in parts of Java and Sumatra. ACIAR's program aligns investment to poor and lagging regions within six eastern provinces, Java and areas of Sumatra affected by the 2004 tsunami. The program aims to lift farmers' incomes by targeting the development of integrated agribusiness, focusing on high-value commodities for which there is strong market demand.

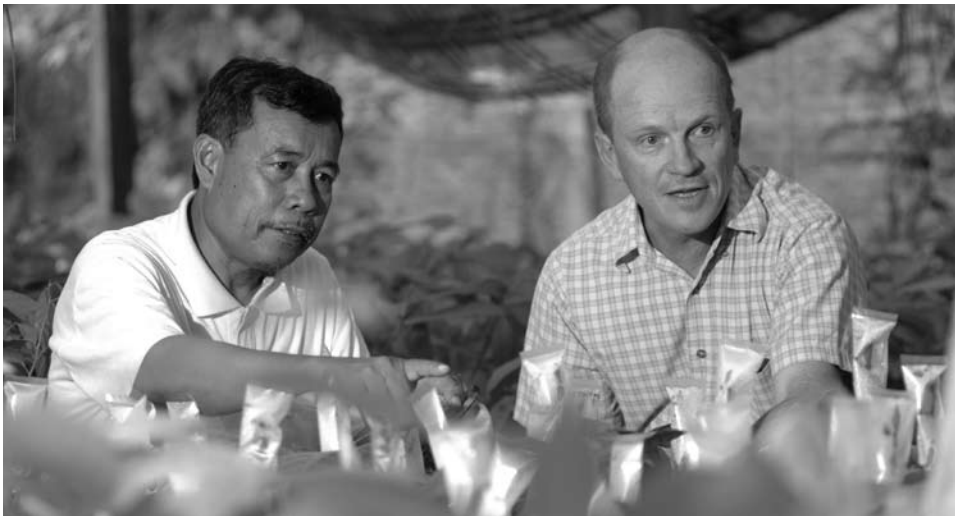
As part of its program ACIAR manages the design and delivery of components of two major regional development programs: support for the market-driven adaptive research component of the Smallholder Agribusiness Development Initiative (SADI) and the rural livelihoods component of the Aceh reconstruction program. The two regional initiatives are funded by AusAID under the umbrella of the Australia–Indonesia Partnership for Reconstruction and Development (AIPRD), comprising $500 million in grants and $500 million in highly concessional loans over 5 years.

Research priorities in 2008–09 are divided across seven subprograms focusing on: improved policies for agribusiness development; biosecurity cooperation; development of horticultural agribusinesses; profitable smallholder aquaculture and agroforestry systems; sustainable fisheries and forestry; profitable agribusiness in eastern Indonesia, and post-tsunami rehabilitation. The ACIAR program emphasises the application of agricultural policy and technical research and development to support economic growth from agriculture, fisheries and forestry.

Achievements

Subprogram 1: Improved policies to underpin agribusiness development

In eastern Indonesia research has helped identify factors **constraining livestock production** in the region's smallholder farming systems. Constraints include: availability and quality of forages, especially during the dry season; poor



Dr Peter Horne, ACIAR's Livestock Production Systems Research Program Manager, (right) with Dr Sahardi Mulia, head of the Institute for Assessment of Agricultural Technologies in South Sulawesi, inspecting cocoa grafts as part of the SADI program.

knowledge and/or capacity to implement optimum feed management practices; limited supplies of readily accessible stock water; bull availability; inadequate cattle housing; labour availability; extended and sub-optimal breeding cycles; diseases; marketing constraints and limited access of smallholders to the formal credit sector for acquiring cattle and livestock-handling materials. Most of the technologies needed to address these constraints have already been developed in Indonesia or elsewhere, and the project has opened the door to make them available to local farmers.

After the Asian currency crisis of 1997 Indonesian policymakers liberalised foreign investment in the retail sector, allowing rapid growth in foreign-invested supermarket chains. As a result, the share of supermarkets and convenience stores in retail food sales rose from 22% in 2000 to 30% in 2004. A study is examining the **transformation of selected high-value supply channels** in Indonesia and their impact on farmers, wholesalers and first-stage processors. The commodities are mango, mangosteen, chillies, shallot and prawns. Based on a series of scoping missions, an improved understanding of the supply chain relationships between supermarkets, processors and farmers has been developed. This has revealed that processors are not as focused on quality as supermarkets, instead relying on trader-level sorting and grading. Farmers are embracing technical change across a number of industries, much of it in response to domestic demand.

A new project commenced in January examining **policy futures for economic development and structural adjustments** in Indonesia. The focus is on integrating policy options to manage the growing global economic uncertainty with environmental pressures. Improving the capacity of Indonesian policymakers through the project is being achieved through their involvement in project activities.

A Collaborative Competitive Grants scheme was developed to help implement a new approach to adaptive research under the SADI umbrella. Using pilot roll-out activities, new agricultural technologies and management systems will be rolled out at a small scale, targeting farmer adoption. An additional $2 million was granted by AusAID through SADI to fund new activities in the production of fertilisers from seaweed

and the production of high-value spiny lobster aquaculture. An institutional development program in collaboration with the World Bank-funded 'Farmer Empowerment through Agricultural Technology and Information' project will help link project activities with 14 extension agencies across Indonesia.

Subprogram 2: Livestock biosecurity

Indonesia and Australia are collaborating to develop **a national surveillance system for classical swine fever, avian influenza and foot-and-mouth disease** (FMD) in Indonesia. Guidelines for a surveillance program for FMD have been established and incorporated into a contingency plan for action, should the disease be detected in Indonesia. This improved plan is of significant benefit to Australia and helps maintain confidence in Indonesia's status of freedom from FMD. If all of Australia's immediate northern neighbours are free from FMD, it reduces the risk of disease incursion into northern Australia.

A study for classical swine fever (CSF) in Alor is ongoing. Project research has determined that syndromic surveillance (using health-related data that precede diagnosis and warn of potential outbreaks) cannot be effectively implemented on Alor until farmers are able to recognise signs of disease and report it to an animal health authority. Alor farmers spend most of their time tending to crops, up to 5 km distant from their households, with the husbandry of animals a low priority. As a result, education relating to pig health, husbandry and nutrition is not embraced, culminating in the farmers' inability to recognise signs of disease.

Adopting better management practices has improved the productivity and profitability of smallholder shrimp aquaculture in Indonesia.

A suite of projects examining the epidemiology, pathogenesis, control and vaccination options of highly pathogenic avian influenza (HPAI) in ducks in Indonesia and Vietnam has made significant progress. HPAI is a transboundary animal disease. Ducks are a known reservoir of the infection and, as migratory birds, have the potential to spread HPAI. In Indonesia serological data show that the prevalence of HPAI infection in sampled ducks and in-contact chickens was relatively low, but that the birds are highly susceptible to infection. About 20% of the duck flocks and 2% of the in-contact chicken flocks had at least one bird exposed to HPAI virus. Outbreaks were common, with nearly half of the monitored flocks experiencing at least one outbreak and mortality high among the chickens. By comparison, in Vietnam, most of the birds in the study flocks were reported to be vaccinated. Serological results indicated that 50% or more of birds per flock had protective levels of antibody. However, no mortality due to HPAI was reported in any of the study villages, suggesting adequate protection.

The H5N1 strain of avian influenza is now endemic in Indonesia, and **vaccine failures leading to disease in vaccinated birds** must be expected. A project is investigating vaccine efficacy and failures in order to improve the effectiveness of vaccination in commercial Sector 3 in West Java. Sixty farms in three districts with the highest concentration of poultry in the province were visited and data collected on flock health, vaccination and management. Analysis showed variable vaccination practices but, importantly, disease outbreaks due to H5N1 are uncommon. This finding supports the current vaccination policies.

Essential to control of HPAI in Indonesia is the **management of animal and animal product movement**. Research examining policy options has demonstrated that prevention of further HPAI spread and eradication from specific provinces (such as Bali) relies on identifying high-risk poultry movements and formulating policy to restrict, manage and/or monitor these movements. In the first year of the project activities were focused on investigation of the poultry markets in Bali and Lombok. The researchers detected low levels of biosecurity practiced by collectors and vendors at times of increased volumes of chicken and duck trading, such as during religious celebrations and festivals. The continued **lack of biosecurity in the non-industrial commercial poultry sector** (NICPS) ensures that HPAI cannot be effectively controlled in Indonesia. Lack of biosecurity past the farm gate, limited trace-back, multiple production cycles, low level of understanding of biosecurity, and minimal price differentiation between healthy and sick birds lead to poor implementation of farm biosecurity systems. Project work is developing cost-effective biosecurity measures with a demonstrated benefit to NICPS farmers. An Indonesian Biosecurity Consultative Group has been set up to develop an industry-driven and supported approach to improving on-farm biosecurity, including creation of a Poultry Biosecurity Centre.

A project is directing efforts to **improving veterinary service delivery** in Indonesia, addressing the challenges posed by the decentralisation of the political system in 2000. The discovery of rabies in people and dogs in Bali in 2008 illustrates the need for greater coordination of veterinary, quarantine and human health services. Objective 1 of the project, to develop a comprehensive Indovetplan for Indonesia, has been customised to accommodate the Bali rabies situation. Progress to improve regional control programs for brucellosis in West Timor, anthrax in the Eastern Islands and rabies in Flores continues. For each disease both technical and economic perspectives of control are being introduced, with action afoot to develop options for improved control and subject them to prospective benefit:cost analysis.

Subprogram 3: Research to underpin development of competitive horticultural agribusinesses

New **cropping models and water management systems** have been developed to support the higher value vegetable production industries of the eastern provinces of Nusa Tenggara Timur (NTT) and Nusa Tenggara Barat (NTB). But despite the significant investment and efforts to encourage uptake of the new systems, very few significant changes of practice have been observed. A study undertaken to discover the reasons for the lack of adoption found a multitude of answers. Constraints included lack of capital and access to credit, market price risk, production risks and inadequate incentives for maintenance of water infrastructure capital assets. The study team also identified a range of cultural, social and institutional problems, resulting in recommendations that extension efforts should focus on smaller farms and on female members of the households.

Rodents are the number one pest of rice in Indonesia and one of the top three pests in Vietnam. Traditionally, farmers have relied heavily on the use of rodenticides, electrocution and spreading sump oil mixed with insecticides onto flooded rice fields to manage the rodent problem, but these can be expensive, are often applied after significant damage has already occurred, and cause environmental problems. ACIAR-funded research has introduced **ecologically-based rodent management** (EBRM), encouraging farmers to manage rodents through community approaches. These have been shown to reduce rat damage, increase yields and reduce the reliance on rodenticides. The level of rodent damage to rice crops has reduced (now less than 4% losses), and higher rice yields are reported in areas where EBRM has been implemented. Project work is now quantifying the significant adoption and dissemination of EBRM that has

Farmers and researchers from CIP are working on sweetpotato-pig production systems in the Baliem Valley in Papua, Indonesia.

occurred, and completing the post-implementation survey on farmers' knowledge, attitudes and practices in Indonesia (Karawang, West Java; and Pinrang, South Sulawesi) and in Vietnam (Ha Nam, Red River Delta; and An Giang in the Mekong Delta).

The temperate highland climate in the provinces of West Java, Central Java, South Sulawesi and NTB enables predominantly small-scale growers to grow **potatoes, brassicas and alliums as cash crops**. A project aims to develop potato, brassica and allium (shallot) production and postharvest systems. Baseline surveys have so far identified constraints to production in potatoes and cabbage, leading to the identification of potential best-bet management recommendations. These are being tested and validated through learning-by-doing plots run through the Farmer Field School system. This research links with a project to **improve incomes and promote sustainable livelihoods** among vegetable farming households in West and Central Java through integrating farmers into profitable supply chains and enhancing their capacity to adopt market-driven technology and innovative practices. The project has established and formalised a broad, diverse partnership among stakeholders in the Indonesian potato/vegetable sector; assessed needs and opportunities for linking farmers with markets through rapid market chain assessment; strengthened capacity of project partners through training on a participatory market chain approach; and facilitated contacts and established working relationships between farmers and other market chain partners.

The diseases **anthracnose and *Phytophthora* blight and whitefly-transmitted geminiviruses** have been studied in chilli pepper in Indonesia, affirming the severity of anthracnose and geminivirus. But losses due to *Phytophthora* wilt have been less than expected. Seeking solutions through integrated disease management (IDM), trials have progressively moved from research stations to farmer fields. Several lines of chilli have been identified as resistant to Java isolates of *Phytophthora*, including several of the 'cabe rawit' type. Of some 92 lines screened for resistance to whitefly-transmitted geminivirus, 15 were found to be immune to infection.

Work has commenced during the year on a project to improve the **international competitiveness of the mango and mangosteen** industries in Indonesia. It seeks to develop systems that will allow these industries to meet the requirements for technical market access and therefore deliver high-quality fruit into the market.

Fruit flies are a major pest in Indonesia, causing significant losses to fruit and vegetable crops. They are also an impediment to fresh fruit exports. Indonesia lacks much of the infrastructure to

Local officers testing ducks for avian influenza at a village in Java, Indonesia

manage this pest. A research team has determined the **geographic distribution and host ranges of the flies** by conducting surveys using traps and host fruits. A list of fruit fly species occurring in West Nusa Tenggara, East Nusa Tenggara, North Maluku, Maluku, Papua and West Papua has been completed after extensive sorting and study of thousands of fruit fly specimens sent to Griffith University. Scientists now have a complete picture of the fruit flies of the Indonesian archipelago, and have listed the seven species of economic importance. A workshop has trained sufficient Indonesian project staff to now enable independent identification of Indonesian fruit flies. The protein bait plant at PT Multi Bintang Brewery in Tangerang, West Java, which was commissioned in March 2008, is now producing fruit fly bait for the field control trials in Indonesia. The bait, registered under the trade name Indo Prima, is an affordable solution for Indonesian farmers.

In Indonesia over 140,000 farmers grow sugarcane, but over the last 40 years productivity has been declining. A project studying the influence of the **most important pests and diseases in the Javan sugarcane industry**, and the development of appropriate management strategies to minimise their economic effects, has been active during 2008–09. Extensive preliminary surveys (over 930 individual crops) in western, central and eastern Java were undertaken, providing foundation knowledge of the distribution of pests and diseases and also refining pest and disease monitoring methods. Information on biocontrol species attacking the major borer pests has also been collected. The incidence of the borer species varied with location and site. A field manual is being written on pests and diseases of sugarcane and management options.

Subprogram 4: Productive smallholder aquaculture and agroforestry systems

A suite of projects to improve the **productivity of smallholder shrimp farming** is underway. Shrimp is the most important export product in the Indonesian fisheries sector, making product quality and food safety important issues for meeting market demands. Two projects are working to increase profitability for smallholder farmers through introducing and improving better management practices (BMPs). The first is working with volunteer farmers in central Java and South Sulawesi to implement BMPs, before scaling up programs to introduce these practices to larger groups of farmers. The Central Java provincial and Pinrang district administrations will fund independent, parallel BMP programs once trials of the practices have been completed successfully. The second project is working at the regional level, in Indonesia, India, Thailand and Vietnam, to create a networking approach for implementing BMPs to smallholder farmers in the region. The Network of Aquaculture Centres in Asia Pacific is leading the work, including the development of methodologies for farmer group certification.

Another regional project, linking Indonesia, Thailand and India, is working to develop a clearer understanding of the transmission mechanisms for the pathogen white spot syndrome virus. The project is improving the use of polymerase chain reaction (PCR) methods to test for the presence of the virus, with researchers from Indonesia, India, Thailand, Sri Lanka, Bangladesh and Burma involved in training on using the methodology for testing.

Complementing this focus on shrimp health is research in Indonesia to classify land suitable for aquaculture farming. Some soils in Indonesia, once disturbed, become toxic to fish as they release acid sulfates. Using land classification and mapping, areas suitable for aquaculture production in South Sulawesi have been identified. Site selection criteria for farmers have also been developed. This project has links to another, focusing on sea cage aquaculture, which concluded in December 2008. Both projects operated under the auspices of the National Steering Committee and Local Advisory Committee in South Sulawesi. The results of the project include a computer-aided design tool for help in assessing potential impacts from sea cage aquaculture operations.

Marine finfish aquaculture is a potentially lucrative industry, with live fish particularly in demand. The biggest barrier to production has been poor survival rates of fish reared from the larval stage. Significant problems have been caused by limited management options for effective larvae rearing, lack of appropriate feeds, and diseases. Using a combination of techniques, significant progress has been made towards improving survival rates. The use of 'trash' fish as a feed has shown that this technique can match or surpass pellet feeds, with survival rates of around 75–95% for selected high-value species. A new project, focusing on yellowfin tuna culturing, has trialled a number of methods to improve the sustainable capture of broodstock, and on larval rearing to identify possible improvements. Viral nervous necrosis, a nodaviral disease, affects diverse marine finfish species and is a barrier to increased aquaculture production. Control strategies for the disease are being developed by a new project using PCR assays to detect the presence of the disease. Biosecurity measures are also being assessed within project activities, along with diagnostic capacities.

Aquaculture of caged fish in inland reservoirs is widespread in parts of Indonesia, but overstocking of fish threatens survival rates of both caged and wild fish. Research is developing management strategies that address both issues, including the development of management practices that have been disseminated among farmers.

Subprogram 5: Sustainable management and profitable use of fisheries and forestry resources

The capture fisheries within Indonesian waters are among the largest in the world and represent a food and income resource for tens of millions of people. This highly diverse set of fisheries supports a range of activities undertaken by small artisanal family groups to highly industrialised and mobile fishing fleets targeting high-value products. The collapse of fisheries (currently a worldwide phenomenon) could have severe social, economic and environmental impacts in Indonesia. Collaborative research is seeking to **develop new, innovative fisheries policy and management frameworks**; develop new, fishery-specific stock assessment processes; and improve monitoring, scientific and policy frameworks for sustainable management of stocks within Indonesian waters.

Two projects are focused on gaining a clearer understanding of fishing practices. The first is developing the capacity to monitor and analyse tuna fishing levels in response to downward trends in catches. As a result of this research, Indonesia has been able to produce catch estimates for key tuna species caught by Indonesian longline boats, and submit this to the Indian Ocean Tuna Commission. Coordinated regional action is essential to managing these and other fisheries. Determining sustainable catch levels is also hampered by illegal, unregulated and unreported (IUU) fishing. A new project is piloting a program designed to help manage IUU fishing using capture and market data, with work beginning to develop a baseline of fish numbers in several fisheries. Already the research has produced new information about the fish catches in several fishing ports and developed a revised approach to data collection for selected fish stocks.

Deforestation and forest degradation are major global challenges. Indonesia has an annual deforestation of 1.5 million ha/year, amounting to an estimated 14% of global deforestation. **Reducing emissions from deforestation and forest degradation** (REDD) is a challenge for Indonesia, with ramifications for post-Kyoto climate change protocols. An ACIAR-funded project is building capacity in Indonesia to better understand and manage REDD, with mechanisms being developed based on project research into the impacts of fiscal decentralisation in the forestry sector. Mapping of deforestation in two districts in Riau province has also begun, and will contribute to the development of policies to manage REDD.

Scientists involved in managing fungal root rot in plantation acacias have uncovered a **diversity of fungi associated with root rot** in *Eucalyptus pellita* (and clones of *E. pellita* hybrids) planted as an alternative species on land previously growing *Acacia mangium*. Two species of *Ganoderma fungus* have been recovered from areas where both the previous acacia and the current eucalypt crop have suffered high losses from root rot. Pathogenicity tests are underway to provide definitive assessments of the pathogenicity of *Ganoderma philippii* against *Acacia mangium*, *Eucalyptus pellita* and *Alstonia solaris*. A risk assessment tool has been developed to provide risk ratings of the infection at sites based on age, rotation, soil type, slope and GPS coordinates. Additionally, ground-penetrating radar has been used for the first time in the Indonesian pulpwood industry to assess root structure and its implications for disease spread.

Acacias are fast-growing species suitable for wood fibre production, capable of achieving high growth and producing high-quality pulp and timber product. At 22 field sites across Indonesia and Australia scientists are exploring the **interactions between genetically improved acacia material and management**. Results thus far have supported the hypothesis that productivity gains will require a combination of both improved management and improved genetics. The combined management and improved genetics gave a 177% increase in productivity in the first year over baseline productivity (no phosphorus (P) fertiliser and unimproved genetics), compared with P fertiliser and unimproved material (65%) or use of improved material with no P fertiliser (32%).

ACIAR-funded research to improve economic outcomes for **smallholders growing teak in agroforestry systems** in Indonesia has three main objectives: to introduce and adapt silvicultural technologies that improve returns for smallholder teak producers; to identify and design financing schemes providing incentives for smallholder participation in profitable teak production; and to enhance market access by smallholder teak producers. The project team has identified some common obstacles faced by smallholders to improving their management practices, including the lack of access to high-quality seedlings, and a lack of knowledge and technical skills to apply proper silviculture techniques. Six farmer demonstration trials established on selected farms are being used to trial best-bet options to demonstrate the benefits of silviculture practices.

Jepara in Java has a long tradition of **high-quality furniture making**, coupled with ready access to high-quality teak. Inefficiencies throughout the value chain currently result in plantation overharvesting, leading to poor incentives for producers and misuse of resources. A project has commenced to specifically enhance the structure and function of Jepara's furniture industry to benefit small-scale furniture producers. A survey has revealed that incomes earned by furniture producers were generally higher than those of average households, while urban and semi-urban areas have varied sources of income. An earlier survey revealed that around 30% of workshop owners surveyed had abandoned their businesses as a result of high input costs and low selling prices for their products. The project is addressing these problems, and in December 2008 the Center for International Forestry Research officially launched the local Furniture Value Chain project office in Jepara to facilitate research activities and stakeholder engagement.

Subprogram 6: Profitable agribusiness systems for Indonesia (SADI)

Projects under this subprogram are further divided into livestock research; field and horticultural crop production, processing and marketing; and estate crops and forest products.

Livestock research

There are prospects of a **more nutritious diet for both the human population and their livestock** in West Timor through modification of the traditional maize-based farming system. Scientists have identified annual and semi-perennial forage legumes adapted to West Timor's semi-arid tropical environment, which includes a long dry season in which food becomes scarce. The project has identified unused soil water at maize harvest, supplemented by late wet season rainfall, as an opportunity to increase productive capacity. Forage legumes able to use these resources have been introduced for growth on fallow lands. A new project, focusing on improving the sweetpotato–pig livestock system commenced in the second half of the financial year. Technologies developed in an earlier related project are included in a new International Fund for Agricultural Development project investing $10.5 million into livelihood improvements in Papua and West Papua.

In South Sulawesi a suite of projects is helping build capacity in the knowledge and adoption of Bali cattle improvement technology. Best-bet activities have been consolidated in 12 study villages across three regencies, establishing a framework for social research, supporting and tracking scale-out, and building capacity. The best-bet process tailors options with individual farmers before design and establishment of on-farm trials. The trials incorporate village nurseries, cattle and forage monitoring and dynamic calendars of activities. In Lombok **scaling-up of herd management strategies in crop–livestock systems** has focused on community and institutional engagement, implementing improved infrastructure and breeding and feeding practices. Breeding management activities were focused on controlled mating through provision of a bull. Project bulls serviced over 1,000 cows in the 6-month period—58% from project kandangs (91% of the total number of mature females) and 42% from neighbouring farms. Small plots have been established at each study kandang to demonstrate new forages, management techniques and aspects of animal nutrition. The performance of calves receiving supplementation at weaning stage demonstrated that those supplemented between 1 and 6 months of age were 43% heavier than the non-supplemented controls. This practice makes the animals more valuable, as males require less time to fatten and reach target weight for export sooner, while females begin reproducing earlier and are likely to produce an extra calf during their lifetime.

The supply chain of the eastern Indonesian beef sector is driven by an increasing demand for beef as a result of rising incomes. The high demand has resulted in a **decline in cattle numbers and average slaughter weights** because productive female cattle are killed and animals are slaughtered at premature weights. Regulations to prohibit the slaughter of females and breeding programs to rebuild herd sizes both seem to have a limited effect. A project to address these and other problems has conducted farm-level and customer interviews at the Jakarta market. The project members now have an insight into the most likely development of the supply chain.

In South Sulawesi there are a number of constraints that limit industry development and market **improvements for goat production**. Developing a more integrated supply chain, with improved production, management and access to markets, could help both the local and export market. A new project commenced during the year to address these constraints, with findings to date indicating a strong demand, tied to cultural and religious requirements, for goats.

Field and horticultural crop production, processing and marketing

A project to enhance **productivity and profitability of tropical pulses** in Indonesia and Australia began with mungbean varietal trials in the Belu district of NTT. The trials identified two new varieties (Vima and Siriti) with yields 30–40% higher than local varieties, suggesting scope for improving productivity. On-farm trials to evaluate peanut varietal and improved management practices in lowland irrigated systems in Lombok demonstrated scope for achieving fresh pod yield of up to 8 t/ha by implementing improved practices, compared to less than 3 t/ha from conventional practices. Research into quality management to enhance effective supply chains for mangoes and rambutans in NTB commenced in September 2008, with the major quality constraints in both crops under investigation. A range of appropriate management interventions were introduced to deal with observed quality constraints, and trials on postharvest fungicides commenced.

Opportunities for marketing citrus from eastern Indonesia are the subject of a project that began with preliminary mapping of the marketing system. The mapping assisted the project team to select three localities with citrus of superior or 'desirable' characteristics: Selayar Island in South Sulawesi (Sulsel); Buton Island in South-east Sulawesi (Sultra); and the Soe region in NTT. All regions grow different and superior quality mandarins (keprok), which are predominately or exclusively consumed locally.

A study of **integrated tropical passionfruit** production systems addresses common issues of production in both South Sulawesi and northern Australia. In South Sulawesi the primary market driver is consistent monthly supply for processing fruit, while northern Australia seeks to fill a high-priced market niche for fresh fruit. Comprehensive disease surveys have been undertaken in Sulawesi and are continuing in north-western Australia. In South Sulawesi the team has identified the disease fusarium wilt (*Fusarium oxysporum* var. *passiflora*) and confirmed that it is a key barrier to production.

A project that aims to generate sustainable, profitable productivity improvements in the **irrigated rice-based farming systems** of South and South-east Sulawesi carried out a rapid rural appraisal of the constraints to rice production in four villages under study. Four control villages were also selected. Major constraints encountered included limited water availability and pest problems like stem borers, weeds and rodents. Nutrient management is also a problem because of the increasing cost of fertiliser and soil fertility problems associated with too much water at certain times of the year.

Estate crops and forest products

Efforts are under way to **improve cocoa production through farmer involvement** in demonstration trials of potentially superior and pest/disease-resistant genotypes and integrated management practices. Trials established in five districts of Sulawesi, each testing 12 cocoa clones, are providing data on flowering and incidence of vascular-streak dieback, the most important disease affecting the vegetative stages of cocoa. Members of the Indonesian Coffee and Cocoa Research Institute, accompanied by Australian project staff, conducted farmer group training sessions on cultural methods of pest and disease management. Project staff members also assisted a farmer group in North Luwu to establish demonstration plots.

NTT, Indonesia's driest and poorest province, has a long history of interdependence between local livelihoods and the international, regional and local trade in **non-timber forest products**. A study of agroforestry systems in West Timor, Flores, Sumba and on Savu has generated a dataset, with the results being collated to inform future research recommendations.

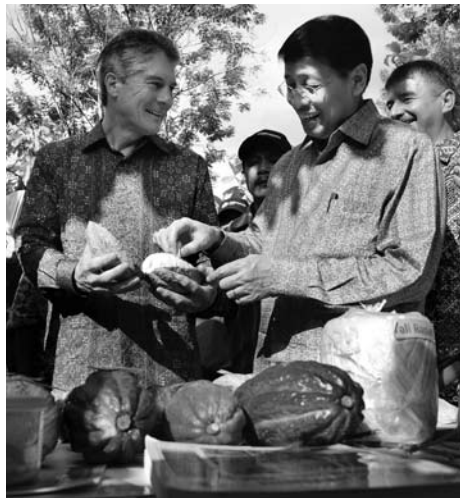
The **international specialty coffee market** is the focus of a project to generate value chain solutions for smallholder farmers in two

provinces of eastern Indonesia—South Sulawesi and East Nusa Tenggara. The project is actively coordinating with international coffee buyers at various stages of project implementation. There are two principal foci for the project: the socioeconomic institutions that underpin smallholder coffee production and trade in eastern Indonesia, and quality assessment that will deepen the understanding of the physical determinants of taste (cup) characteristics of coffee in the region. A socioeconomic survey involving 796 coffee-growing households was completed in March 2009 to generate a comprehensive baseline account of farming practices, household budgets and farm-gate markets in each district.

Subprogram 7: Technical cooperation to underpin medium-term rehabilitation and development of agriculture and fisheries in Aceh

Work continued in efforts to restore **annual cropping in tsunami-affected areas** of Nanggroe Aceh Darussalam (NAD) province. The project team developed and demonstrated soil management practices to increase productivity of annual crops and strengthened the technical capacity of extension services in Aceh. The main factors affecting crop production immediately after the tsunami were social dislocation and high soil salinity. Salinity levels have been assessed and monitored with electromagnetic induction instruments (EM38), with recommendations to delay cropping until rainfall had leached the salt through the soil. Crop experiments and demonstration trials compared the performance of rice, peanut and soybean varieties; agronomic management practices; organic amendments; fertiliser packages; and local farmer practice, with significant yield increases reported in rice, peanut and soybean crops.

Efforts to introduce integrated soil and crop management for **rehabilitation of vegetable production** in the tsunami-affected areas of NAD province bore fruit over the past year. Compost, animal manures, lime and appropriate use of inorganic fertilisers have been identified for soil remediation and have been tested in farmer-participatory research trials. Eight trials were successfully completed, four with chilli and four with cucumber, in farmers' fields in four districts. Composts are being recommended in adapted farmer field schools and extension publications. Data collected are now yielding an extensive analysis of the vegetable sector in five districts. Initial results showed that, among the project-targeted vegetables in Aceh, chilli production provided better income and employment to farmers than other crops.



Australia's Minister for Foreign Affairs the Hon Stephen Smith MP and Indonesia's Foreign Minister Hassan Wirajuda meeting with farmers, researchers and buyers at a demonstration cocoa farm in South Sulawesi in August 2008.

A project aims to build **more profitable and resilient farming systems** in NAD province. The research team has initially surveyed farmer and market activities in four villages in Aceh. The Indonesian Soils Research Institute is examining the landscape and climatic constraints to the local farming systems, and research activities related to soil amendments have commenced. Six NGOs working in agriculture in Aceh have expressed interest in participating in project activities, and training workshops are helping new field extension staff working in the villages targeted for the farmer surveys.

Vietnam

AOP budgeted expenditure in 2008–09	$2,873,079
Actual expenditure in 2008–09	$2,652,372
Expenditure in 2007–08	$2,362,549
Expenditure in 2006–07	$3,145,372

Key performance indicators	Performance 2008–09
New linkages developed between ACIAR and programs of AusAID and other donors and NGOs in north-western and central coastal Vietnam	In the north-western highlands collaboration with the Danish International Development Agency (DANIDA) and the development-oriented agricultural research centre CIRAD is commencing. In the south-central coast program collaboration has been established between ACIAR, the AusAID Capacity building for Agriculture and Rural Development (CARD) program and the Asian Development Bank 'Markets for the poor' project, with funding also involving the Department for International Development (DFID)-UK and AusAID.
A major new program designed and initiated using Australian technical expertise on soil and water management for south-central coastal regions	A $2.7 million, 4-year program on sustainable and profitable crop and livestock systems for south-central coastal Vietnam commenced.
Methods for culture of higher value mariculture species developed and communicated to industry stakeholders	With ongoing ACIAR support, the Asia–Pacific Marine Finfish Aquaculture Network has helped extend hatchery technology for marine finfish. A new project has been approved to develop formulated diets to replace low-value fish with high-value marine species. Technology for mollusc hatchery production has been transferred to Vietnamese collaborators.
A new program initiated that targets production of high-value products from acacia and eucalypt plantations	Site management and silvicultural systems to optimise the production of acacia sawlogs suitable for the production of furniture and other high-value products are being developed. A new component project targeting the production of high-quality peeled and sliced veneers from Vietnam's extensive acacia and eucalypt plantations is in development.
A program developed through consultations on technical needs for improving agricultural livelihoods in north-western mountainous provinces	Formal Vietnam Government consultation workshops agreed the content of a program, and the first major project activity, 'Improved market engagement for sustainable upland production systems', has been designed and implemented. A second project in the program, focused on improved livestock systems, is currently under design.

Position

In 2008–09 ACIAR's program in Vietnam has focused on two regions where poverty has persisted: the south-central coast and the north-western highlands. Australian agricultural expertise is well matched to both regions, in the south with poor, sandy soils under water-limiting conditions and in the north-western highlands with high-value temperate horticulture crops. The focus on the two regions reflects the significant economic growth that has occurred in Vietnam in recent years. Vietnam is now on the verge of becoming a 'middle-income' country, the recent growth being driven by market competitiveness, a demand for exports and increasing levels of foreign investment. Despite this growth, rural areas have received less in benefits, in particular in the two areas of focus for ACIAR.

ACIAR's research priorities have, in the past, included links with the AusAID Capacity Building for Agriculture and Rural Development (CARD) program. New linkages to AusAID programs as well as those of other donors, including NGOs, are being developed. Research projects are designed to build links between central research institutions and provincial research and extension departments. Projects operate within five subprograms: market competitiveness through improved agribusiness and biosecurity systems; development of mariculture industries; higher value plantation products; and subprograms focusing on the south-central coast region and the north-western highlands.

Achievements

Subprogram 1: Securing market competitiveness of Vietnamese agricultural, fisheries and forestry products through agribusiness and biosecurity

Diseases cause large losses to crops across the central provinces of Vietnam. **Plant disease diagnostic laboratories** have been established at each of the Plant Protection Sub-departments

A pineapple grower at the floating market in My Tho City, in Vietnam's Mekong Delta region.

(PPSDs) in Nghe An, Quang Nam and Thua Thien-Hue provinces, and at the School of Agriculture and Forestry at Hue University, serving approximately 1.5 million farmers. Co-funding enabled establishment of greenhouses at Quang Nam and Nghe An PPSDs. Seven team members from the provincial sub-departments have received training in laboratory and field diagnostics and the design and management of field trials and data analysis. Trainees are now able to independently diagnose common root, stem and foliar fungal and bacterial pathogens; design, implement and analyse field trials; develop IDM strategies; and teach IDM and best-practice fungicide use to district and commune staff and farmer groups. Furthermore, they can now consult with Australian counterparts on diagnoses via the internet in English with digital images.

Studies on **huanglongbing (citrus greening)** and the vector that transmits this disease (the Asiatic citrus psyllid *Diaphorina citri*) continued in Vietnam and Indonesia. As in previous years, populations of *D. citri* and the incidence of huanglongbing remained low in an 0.5-ha guava-interplanted king orange orchard in which mineral oils, pesticides and other management strategies are being compared for control of the psyllid in southern Vietnam. The orchard, at Cai Be in Tien Giang, was planted in 2004. Differences among treatments remained undetectable and no psyllids were observed. Other studies and observations in the Mekong Delta, and research in Indonesia and China, continued to indicate that low incidence of the psyllid and the disease is due to the impact on psyllid behaviour of volatile compounds released by the guava trees.

In Vietnam demand for pork is increasing rapidly. Successful **commercial smallholder pig farming** may help to meet demand while alleviating some of the country's widespread rural poverty. A project is identifying options for technology, policy and forms of market institution or coordination that will give smallholder pig producers in Vietnam better access to higher value market chains and thus lead to higher incomes. Findings from the project so far are relevant to Vietnam's long-term strategy for the development of its livestock industries, and Vietnamese Government officials involved in the formulation of this strategy have shown interest in project results.

Mr Vu Ngoc Ninh from Dong Nai province, Vietnam is one of the farmers who purchased pigs with improved genetics under the suite of ACIAR-supported pig projects.

Subprogram 2: Development of high-value aquaculture industries

Molecular genetic methodologies are integral to the **study of wild fish populations** and are invaluable in aquaculture, helping to maintain high levels of productivity and long-term sustainability in culture lines. Senior scientists at Vietnam's Research Institute for Aquaculture No. 3 (RIA3) have identified building a strong capacity in applied genetics as a major goal, and recognise that any development in this area must be sustained for the future. A project provided training, capacity building and experience in small model projects on local fish species of importance for RIA3 scientists destined to be part of the new applied genetics research group. The scientists also learnt how to develop basic learning modules that could be incorporated into advanced undergraduate/postgraduate units for the University of Fisheries at Nha Trang.

Hmong girls in northern Vietnam sell handicrafts to tourists.

Smallholder shrimp farming has been important for rural development for three decades in South-East Asia. More recently, disease issues and oversupply of global markets have meant that shrimp farming no longer represents a viable livelihood for many smallholders. Many ponds have been abandoned (up to 70% in some countries/regions) and farmers are eager to find alternative species to farm that present a lower risk than shrimp. Sandfish (sea cucumber *Holothuria scabra*) has many traits that could make it an **ideal species to replace shrimp** for smallholders. It is a low-food-chain species that grows well feeding only on organic matter in the enriched sediments of shrimp ponds.

Research in Vietnam has developed hatchery and juvenile production techniques capable of operating at an appropriate technology level to replace shrimp farming. Now an ACIAR-funded study has greatly furthered the knowledge about required water management in ponds. Early trials of pond farming were marred by high mortality rates associated with an influx of fresh water during tropical wet seasons. Farming sandfish in ponds now appears a reality for Khanh Hoa farmers (north of Nha Trang) due to the effective water management systems developed.

Within its portfolio of aquaculture research in Vietnam, ACIAR has funded a project to develop low-cost diets for catfish and tilapia, another for mud crabs, and a third focused on sustainable tropical spiny lobster aquaculture. A project is revisiting this work, with the overarching objective of examining the policy, institutional and economic constraints to the **adoption of the low-cost formulated diets** developed in these technical projects. The first activity is value chain analysis, where prices, costs and margins at each stage of the value chain are being analysed to indicate where the policy or institutional environment may be creating distortions. Initial value chains for the three fish species of focus (lobster, mud crab and tilapia) have been drafted. A second activity is whole-of-household economic modelling, which will help to assess the cost-effectiveness of potential pelleted diets formulated in the ACIAR-funded technical projects compared with current diets, and to analyse the economic impacts of potential policy and institutional constraints on adoption of these diets.

Subprogram 3: Towards higher value plantation forestry products

Vietnam has a rapidly expanding plantation estate of acacias. Community/smallholder farmers account for a substantial part of that estate, and solid wood from acacias offers them an opportunity to generate a high income. However, success depends on **the quality of silvicultural systems** adopted. A project seeks to quantify the role of pruning and thinning in community forests to optimise tree size and log distribution, to examine the roles of site and soil management in the sustainable production of community forests grown for sawlog and pulpwood production, and to relate potential productivity of *Acacia auriculiformis* and acacia hybrids to site parameters in resource-limited environments in Vietnam. It is developing tools that will assist farmers to manage plantations already in the ground, thus helping them to produce high-value sawlogs rather than lower value pulpwood. In early work, trials are being established to quantify the roles of fertiliser use, pruning and thinning to optimise tree size, log distribution and economic returns from plantations managed for sawn timber.

Women in Vietnam lead the way in the safe production, utilisation and market development of indigenous vegetables.

Subprogram 4: Optimising water and soil management for profitable and sustainable production in south-central Vietnam

Vietnam is the **second largest coffee producer in the world**, and approximately 40% of national coffee output originates from Dak Lak province. In recent years coffee production in Dak Lak has been significantly constrained by dry-season water shortages, and the sustainability of smallholder coffee production in the region has been questioned. Increasing irrigation water-use efficiency on coffee smallholdings in Dak Lak would generate sizable social welfare increases to inhabitants. A study found that coffee smallholders were inefficient irrigators, applying more than twice the amount of water required to maximise coffee yields. By adopting a technically efficient irrigation schedule, water input could be reduced from the current average application of around 1,050 L to 550 L per tree per irrigation. Achieving this water input would increase production by around 0.5–5.0 t/ha, and achieve an average 10% reduction in variable irrigation costs.

World Vision Vietnam has implemented projects for the poor in Dong Giang district (Quang Nam province, central Vietnam) to improve their living standards through activities such as health services, education and livestock development. An ACIAR-funded initiative is contributing to the **World Vision Vietnam Area Development Plan** by improving the capacity of its staff and community leaders to administer and manage projects. It is anticipated that improved cattle production and increased income from livestock for participating households will be achieved within the project period, with wider scale benefits in the longer term. In cooperation with the local District Agriculture Extension Station and Hue University of Agriculture and Forestry, the project has helped to improve project planning and management for the local hamlet facilitator's network. A 3-day training course on credit loan management has also been conducted for commune accountant and commune members. Currently, each project commune has a recycle credit loan scheme for cow raising. Monitoring results showed that, after the training, eight of the 10 communes managed their loans better. More than 60 commune and hamlet cadres and about 300 farmers with basic knowledge of cow raising also received more advanced training, and the farmers received three different leaflets specially written for them.

A promising approach to improving agricultural development in the coastal provinces of central Vietnam is to **expand cashew nut production** using small-scale farm dams to capture wet-season run-off, and irrigation technologies that are economically and socially appropriate. There is also potential to improve soil fertility and integrate nut production with forage production using groundcover species such as *Arachis pintoi*. A project is seeking to improve smallholders' incomes by increasing the profitability of cashew nut production. The project is demonstrating the potential for developing and using small-scale on-farm water storages, evaluating the use of waste materials as soil amendments for improving water and nutrient-use efficiency, and promoting strategies that will enhance adoption of management strategies that enable high irrigation efficiency and long-term soil fertility improvement. Achievements during the second year of this project include: establishment of cashew and mango irrigation field experiments and demonstration trials in Binh Dinh and Ninh Thuan provinces; establishment of biochar field experiments with groundnut and cashew in Binh Dinh province; completion of a soil nutrient management workshop and intensive small-group technical sessions for the Vietnamese team; and a Binh Dinh cashew farmer field day held by the Vietnamese partners.

In Ninh Thuan a table grape field trial was established to demonstrate how irrigation scheduling using mini-evaporation-pans and drip irrigation could improve water and nutrient-use efficiency and reduce nutrient leaching. Irrigation using the mini-evaporation-pan reduced irrigation inputs by more than 30% without any apparent consequences for grape yield or quality. Widespread farmer adoption of these simple, inexpensive irrigation strategies could reduce nutrient leaching at the catchment scale, ultimately delivering environmental and community health benefits by improving the quality of groundwater used for drinking, livestock and irrigation.

Mr Do Hong Tuan, a SOFRI research assistant discusses disease control strategies with Mr Le Van Bay, a citrus farmer.

Subprogram 5: Developing market opportunities for communities in the northern and north-western highlands of Vietnam

The north-western provinces of Vietnam are characterised by upland agricultural systems, relatively high levels of poverty and high levels of ethnic diversity. Although many large donor organisations are focusing on these poorer provinces with community-based development projects, only limited research results suited to the region's agroecological and socioeconomic conditions are available so far to help farmers improve their farming practices. An ACIAR-funded study conducted a **general profiling of agricultural research and development** priorities and activities in all six provinces of the north-western part of Vietnam (Lai Chau, Lao Cai, Yen Bai, Dien Bien, Son La and Hoa Binh), and collected detailed information on agricultural R&D needs and opportunities at provincial, district, commune and village levels only in Lai Chau, Lao Cai and Yen Bai provinces.

The study found that the main constraint faced in livestock management was the lack of available feed of adequate quality and in sufficient quantity, particularly during the winter season, causing poor animal health and even death under severe climatic conditions. Veterinary services were limited outside the district capitals. Crop management is based mainly on traditional practices, and farmers have limited access to agricultural inputs, technologies and information due to remoteness and communication barriers. Specifically, farmers and local officers expressed the need for locally adapted varieties of both seasonal food crops and perennial cash crops such as tea and fruit, suitable crop and pest management practices tailored to agroecological and socioeconomic conditions, and postharvest technologies to add value to the produce for marketing purposes.

Vietnamese sources have identified **non-astringent persimmon** as a new commercial crop. A project is enhancing the productivity, yield and fruit quality of persimmon in Vietnam by changing from the traditional astringent varieties to new non-astringent varieties that can be grown using low-cost, best orchard management practices. To enable new technologies for growing persimmons to reach Vietnamese farmers, four demonstration orchards have been set up on selected farmers' properties and two research stations. The project team has carried out top-working of traditional astringent persimmon trees by grafting in new non-astringent varieties, which can be eaten when hard and will carry to market while still firm. Bud wood of Fuyu and Jiro varieties was collected in July and September 2008 from high-quality sources in Australia, and prepared and exported to Vietnam.

There is increasing **demand for indigenous vegetables** in Vietnam and for women to play a significant role in their production. Increasing demand also exists within Australia for products within the Asian vegetable range. A project seeks to improve farm income in rural areas of Vietnam by increasing the skills of women in the safe production, promotion and use of indigenous vegetables. The project has commenced in three communes in Tan Son district, Phu Tho province. In line with the participatory focus of the project, commune teams have formed and selected indigenous vegetables to focus on in each commune. Workshops were held to increase the understanding of participatory approaches among local officers, extension workers and Women's Union staff.

The project is also analysing and quantifying existing and potential market opportunities, assessing factors that may improve the competitiveness of those vegetables in the marketplace and developing supply chains that will continue to support the development of community-based indigenous vegetable production. The Centre for Agrarian Systems Research and Development, whose central tenet is to make markets work better for the poor, has undertaken research to establish economic benchmarks and market potential for development of selected indigenous vegetables in the three communes.

Other projects

Protein is frequently the main constraint for the improvement of pig performance in South-East Asia. Because of this most Asian pig production

Durians, like these on sale at a market in Thuy Tay village, Tien Giang province, are a valuable source of income for smallholders. [Photo: Brad Collis]

Ducks waiting to be tested for highly pathogenic avian influenza (HPAI) in the Mekong Delta, Vietnam, as part of research into the epidemiology, pathogenesis and control of the virus.

countries have high dependence on importation of various protein meals. The long-term viability of such pig industries is dependent on the ability of these countries in the future to **access cheaper local sources of non-conventional feeds**. Rubber seeds are a substantial by-product of rubber production that currently have little use in animal feeding because, despite having a reasonable level of protein content, they also have an anti-nutritive component. A project is attempting to make the rubber seeds more digestible for pigs by processing them to remove cyanide. A digestibility experiment conducted at the Institute of Agricultural Sciences of Southern Vietnam evaluated the digestible energy and amino acid value of diets composed of various treated rubber seed meals (RSMs). The results indicate that the treatment protocol has successfully improved the feeding value of rubber seed in pig diets when compared to the normal commercially available RSM.

Preliminary research funded by ACIAR and AusAID has verified in field trials near Hanoi that the **plant growth-promoting rhizobacteria** effect can reliably increase the average yield of rice by 10–20%. A biofertiliser product, now registered as BioGro, has been developed. A project seeks to understand the function of the biofertiliser, while at the same time promoting its wider adoption in Vietnam and possible commercialisation. Field experiments, mainly in Vietnam, have led to greater understanding about when and how to inoculate with BioGro to obtain maximum benefits for farmers. In particular, the project extended experimentation with the biofertiliser to the Mekong region in southern Vietnam, a major rice-growing area. The field experiments demonstrated the reality of the biofertiliser principle that chemical fertiliser applications can be halved while obtaining yields similar to those with normal farmer fertiliser application rates. Much of the benefit appears to flow from the reduced use of urea and associated cost savings.

The Philippines

AOP budgeted expenditure in 2008–09	$3,961,952
Actual expenditure in 2008–09	$3,728,893
Expenditure in 2007–08	$3,312,314
Expenditure in 2006–07	$3,476,268

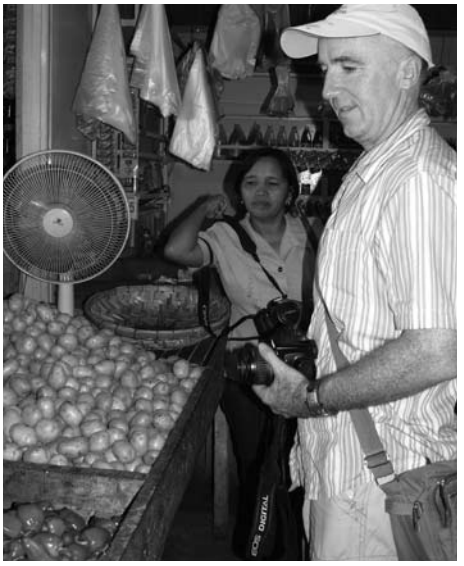
Key performance indicators	Performance 2008–09
Two major new horticultural programs that address major constraints in horticultural value chains in the southern Philippines underway	Two new initiatives in the southern Philippines, the first targeting constraints in mango, papaya, durian and jackfruit value chains, and the second enhanced profitability of solanaceous crops, protected cropping and other high-value vegetable crop value chains, are both underway.
Successful adoption by farmers of better herbicide-use strategies and weed management options in direct-seeded rice	Herbicide-use strategies and weed management techniques have been disseminated to farmers, providing them various options to control weeds in direct-seeded rice.
Community adoption of a multi-stakeholder approach to optimising soil and water resource sustainability and farmer incomes in southern and northern Luzon	Research on enhancing agricultural production by sustainable use of shallow groundwater, and minimising agricultural pollution to enhance water quality, in Laguna de Bay has supported farmers by providing technologies to manage water resources sustainably.
Institutionalisation of the national landcare program through a Philippines-led organisation	Efforts to institutionalise the landcare movement at the national level continue. Grassroots regional landcare initiatives are having significant success.
Improvement in tree seedling supply resulting from economic and policy changes in the Philippines nursery sector in at least two provinces of the southern Philippines	Seed supply has been increased through piloting of new nursery accreditation and seedling certification policies, and development of nursery accreditation guidelines, policy and strategies for implementation.

Position

ACIAR's Philippines program focuses on two broad areas of priority: increasing the productivity, marketability and international competitiveness of agricultural products; and improving the management of land and water resources to benefit smallholder farmers. Each is the subject of a subprogram of research activities. These activities are complemented by a third subprogram addressing regulatory, policy and technical constraints. All three subprograms help achieve objectives under the Australia–Philippines Development Assistance Strategy (2007–11), which focuses on three pillars: economic growth, basic education, and national stability and human security. ACIAR's projects link applicable biophysical, economic and market

development research to the AusAID Rural and Private Sector Development Program, as well as the AusAID-funded Philippines–Australia Community Assistance Program. A new Philippine Council for Agriculture, Forestry and Natural Resources and Development – ACIAR Memorandum of Understanding (MoU) was signed on 7 April 2009. The MoU outlines consultation and cooperation arrangements to identify key agricultural research and development areas, and the communication of the results emerging from this.

Research projects help to improve the productivity of selected commodities, particularly in horticulture, to help marketability and international competitiveness in light of recent trade liberalisation. A significant proportion of Philippines farming is carried out on fragile sloping lands or sensitive watersheds, creating challenges to intensify production without increasing degradation. There is a greater emphasis on the southern Philippines, given that that region has the most development needs.



Dr John Oakeshott, ACIAR's in-country coordinator for the multidisciplinary fruit and vegetable program, inspecting vegetables in a market in the Philippines.

Achievements

Subprogram 1: Increasing the market competitiveness of Philippines agricultural products

1A: Meeting market specifications for horticultural products

The El Niño Southern Oscillation affects the Philippines and Australia, and both countries routinely rely on **seasonal climate forecasts** to prepare for unfavourable weather. The challenge is to find knowledge from climate science—seasonal climate forecasting information—that is communicated in a timely manner in a form that can be understood and acted on. A project has provided extra resources to the meteorological service, Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), to engage with decision-makers and intermediaries in local government to lift the country's capacity to undertake seasonal forecasts. A highlight of the project was the development of a game that simplified instruction on the use of probabilistic seasonal climate forecasts, and this has been used with farmers and advisers in both Australia and the Philippines. The game has attracted interest from the head office of the World Meteorological Organisation in Geneva and from meteorological services in Pacific island countries, India, Africa and Brazil. PAGASA plan to institutionalise the methodologies of the project within their own systems.

1B: Higher returns from horticulture products

In the Philippines **mangoes are an important crop for plantation and smallholder farming** in dry regions. Despite a range of measures

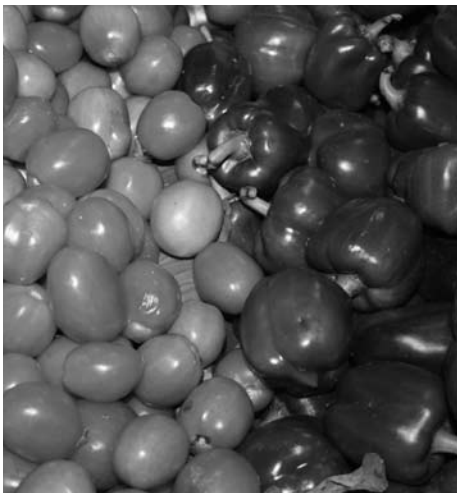
Dr Gamini Keerthisinghe, ACIAR Research Program Manager, Soil Management and Crop Nutrition (far left), with Australian and Philippino project staff visiting field sites.

including pesticides and baiting, no reliable pest controls exist, and this can lead to losses of up to 40%. Establishing disinfestation and meeting quarantine compliance is expensive and time consuming. A project is introducing integrated field management, which includes improved monitoring, control and detection of pests.

The project has identified five insect pests that damage mango leaves, flowers and fruits. On fruits, mango seed borer contributed much of the damage, with an average fruit damage of 19.5%, followed by mango fruit fly at 11% and cecid fly at 3.5%. IPM interventions successfully reduced the overall fruit damage to 4.8% and gave significant yield of 140 kg per tree, compared with farmers' practice with damage of 7.5% and yield of 50 kg per tree.

A major program thrust aims to improve the smallholder and industry **profitability and export competitiveness of selected tropical fruits** in the southern Philippines. Fruit crops targeted are mango, papaya, durian and jackfruit. The primary audience for the outcomes of this program are medium- to large-scale commercial fruit growers and farmers, predominantly in the regions of Leyte, northern Mindanao–Cagayan de Oro and southern Mindanao–Davao. This program has six major components. Some of the highlights of the research during the past year included work on the supply chain analysis of Philippine papaya. The research team visited buying stations, wholesale and retail markets, consolidators' warehouses and supermarkets. They determined that a multilayered distribution and disaggregate sector characterised the papaya supply chain. Between the farm and the final market the chain undergoes 10–12 handling steps. Enhancing awareness by the handlers as well as the key players and decision-makers in the chain on the role of appropriate postharvest handling is one of the initial steps in improving the supply chain.

Another major program thrust is studying **enhanced profitability of selected vegetable value chains** in the southern Philippines. Components of this huge study include integrated soil and crop nutrient management in vegetable crops, protected cropping structures to help farmers grow crops in the wet season, and novel approaches to controlling bacterial and fungal diseases. The project has also undertaken



Improving the quality and quantity of vegetables getting to market in the Philippines not only increases farmer income, it also provides nutritional benefits.

a review of the institutional fresh vegetable markets in metropolitan Manila, the Visayas and Mindanao. The market review revealed considerable differences in quality between the modern retail supermarkets, the food manufacturers and processors, the food service sector and the needs of the traditional wet market. Furthermore, regional differences in climate and topography influence the range, quality and quantity of vegetables available from local producers; and differences in household income, tourism, transport and infrastructure shape both the institutional demand and the extent to which vegetables are traded between regions.

Pest and disease management for brassica vegetables helps improve productivity for farmers in the Philippines.

1C: Competitive and sustainable aquaculture production

The **bivalve mollusc industry** is well established throughout the Philippines archipelago, based principally on oyster and mussel culture. However, considering the overall importance of aquaculture in the country, and the well-developed research and regional administration networks that exist, mollusc culture has not shown the same level of growth as elsewhere. In addition, there exist significant regional differences within the Philippines; for example, Luzon growers typically obtain better prices for their product than Western Visayas growers, and production volumes are also variable between regions. Furthermore, there is no export market for Philippine bivalves despite increasing international demand. A scoping study conducted to obtain an industry overview of these two regions pinpointed differences between Luzon and Western Visayas—notably higher growth rates, differences in culture systems, different demographic profiles of industry participants and differences in microbiological status. The results will lead to further research to develop the industry in Western Visayas, with a view to both equalising and enhancing the prospects for regional production and export markets for bivalve products.

Subprogram 2: Farmer-based land and water resource management for profitable and sustainable agriculture

A project involved the study of **herbicide-use strategies and weed management** options for Philippine and Australian cropping. A survey of 400 rice growers in two major rice-growing regions, Nueva Ecija and Iloilo, established baseline weed management practices used by farmers, and scoped farmer perceptions of weed issues and weed management options. The survey found that farmers were highly dependent on herbicides (spraying from one to

Australian Youth Ambassador for Development Scott Graham explains the importance of soil testing in organic gardening, as part of the Philippines landcare program.

three times per season) and were using herbicides that had a high risk of leading to herbicide resistance. The research team initially established four field sites for on-farm trials of integrated weed management (IWM) versus farmers' practice, then expanded to four additional sites. At all the study sites the team observed reduced weed weights, increased yields, higher profits and reduced number of herbicide applications when IWM was applied to control weeds compared with farmers' practice. An evaluation after two to three seasons indicated that 75% of the cooperators and 10% of neighbouring farmers were adopting IWM on their farms.

Research efforts have been underway to **minimise agricultural pollution and enhance water quality** in Laguna de Bay (Philippines) and Mt Lofty Ranges (Australia). In the Philippines four sites are under study—Lucban (vegetable production system), Pagsanjan (rice production system), Cavinti (coconut and mixed land use) and Majayjay (piggeries) in the Pagsanjan–Lumban catchment. Analysis of water samples for nutrients, total suspended sediment and selected pesticides continued during 2008 at these four sites, which had been previously instrumented for continuous monitoring of water flow and a range of water quality parameters. Grab samples were also collected at the confluence of the Balanac and Bombongan rivers, close to the outflow to Lake Laguna, to provide an indication of the nutrient, sediment and pesticide concentrations entering the lake.

Landcare has been successfully adopted at three sites in Mindanao, in part through ACIAR project efforts, with substantial positive impacts reported at the grassroots level during an end-of-project review held in April. Both smallholder farmers and agro-enterprise operators are benefiting from the project's impacts. A substantial component of the project has been the **enabling of the Landcare Foundation of the Philippines Inc** (LFPI), helping it to evolve and take on defined roles and responsibilities for the broader development of landcare in the Philippines. A 5-year strategic plan for LFPI was developed, approved by the Board of Trustees and implemented.

All three regional programs showed significant outcomes and impacts: in the northern Mindanao program, through the agroenterprise development work with a banana marketing cluster at

Claveria and two vegetable marketing clusters in Lantapan; in the southern Mindanao program, through the agroenterprise development work with a vegetable marketing cluster at Ned and the testing of a landcare approach in a conflict area of Muslim Mindanao; and in the Bohol program, through the successful adaptation of the landcare approach for securing vegetable gardens for households in the municipality of Pilar. Deployment of an Australian Youth Ambassadors for Development volunteer, Scott Graham, at the Bohol site assisted with skills-building in evaluation of soil and soil health improvement, and included the production of a soil-health training book printed in both English and Visayan.

On Bohol Island in the Philippines there are opportunities for farmers to reduce some of the negative aspects of agricultural activity through the **introduction of conservation techniques**, undertaken in association with existing landcare approaches that provide training and encourage adoption. Building on the experience and expertise developed through earlier ACIAR projects, a project is promoting the adoption of improved farming practices on highly erodible soils on steeply sloping uplands in two upper watersheds in Bohol. A key objective of this project is to quantify, demonstrate and provide farmers with examples of the environmental and farm-level economic benefits that can be realised by implementing selected best management practices for soil, water and crop management in affected areas. To this end the project team has established three improved practice and three conventional practice farmer-managed demonstration sites in the upper Inabanga watershed, focusing on a corn–cassava rotation on the highly erodible soils of the sloping uplands. The project has actively introduced improved farming practices with the potential to increase farmers' production.

Philippino farmer Eduardo is part of the 'Landcare' project which taps into the enthusiasm of communities to work together for a common objective - improving their livelihoods.

Subprogram 3: Addressing regulatory, policy and technical constraints to the adoption of research outputs

ACIAR project scientists have determined that the current organisation of public- and private-sector nurseries in the Philippines has not provided farmers with seedlings of appropriate quality in an equitable manner. A project aims to **improve the quality of nurseries** in both these sectors and ensure better integration between them, and introduce better market structures that address issues of unmet demand for seedlings. The pilot testing of a nursery accreditation and seedling certification policy commenced in three municipalities. In early 2009 team members led the development of a draft national policy for an accreditation scheme for nurseries. During the year the project developed a database of mother trees in Leyte, and this has been distributed to private nursery operators, managers of government nurseries and other interested parties. A similar database is being compiled in the study area in northern Mindanao. The project also established a seed centre at Leyte State University. This centre has distributed seeds of various species to partner municipalities, disseminated a nursery best management practices manual to nursery operators, and provided information of nursery locations to seedling buyers. A workshop in Manila briefed national and provincial government representatives on progress to date as part of measures to help institutionalise the policy outcomes of the project at a national level.

East Timor

AOP budgeted expenditure in 2008–09	$1,809,071
Actual expenditure in 2008–09	$2,603,453
Expenditure in 2007–08	$2,789,967
Expenditure in 2006–07	$1,592,108

Key performance indicators	Performance 2008–09
Ongoing success in the implementation of jointly funded ACIAR–AusAID 'Seeds of Life 2' project in close partnership with Ministry of Agriculture and Fisheries (MAF), including development of an on-farm demonstration trial system, a farmer participatory research manual and at least two new crop varieties released and deployed by farmers	The release of varieties of maize, rice, peanut and sweetpotato have been followed by two new cassava varieties. All crops show yield advantages and high farmer acceptance in the on-farm testing system that is supported by a detailed and well-targeted 34-page manual. Hundreds of farmers are more food secure and many are now selling agricultural produce for the first time.
At least three East Timorese researchers involved with an ACIAR project undertaking postgraduate study in Australia as John Allwright Fellows	Five researchers are currently studying in Australia, a sixth student submitted a thesis in 2008–09 and a seventh scholar is expected to start in June 2009.

Position

ACIAR's program focuses on the immediate needs of food security, poverty reduction and capacity building. Agriculture provides livelihoods for more than 80% of the population of East Timor. The major activity in the program is the jointly funded ACIAR-AusAID 'Seeds of Life 2' project, which aims to build on a predecessor project by improving crop production through the introduction of planting material for staple crops. Other projects focus on weed control and on building agricultural knowledge and R&D capacity to support East Timor's research scientists.

Achievements

The **Seeds of Life (SoL) program** within the East Timorese Ministry of Agriculture and Fisheries (MAF) expanded its activities into seven of the country's 13 districts during the 4th year of its implementation. Rehabilitation of research stations advanced considerably over the past year, and the main research-related buildings at Betano Research Station are now complete and operating. In 2008–09 the MAF added to these with the construction of a large warehouse, a meeting building, one house and a tractor repair shed. One house at Loes Research Station was rehabilitated in January 2009. Construction commenced in June for rehabilitation of the remaining buildings. An Australian volunteer who commenced a 16-month assignment at Loes station in May 2009 is helping supervise the rehabilitation. The research station site at Darasula, Baucau, has been fenced by MAF, a station manager assigned to oversee its development and an environmental site assessment drafted.

One of the high-yielding maize varieties (SW5) that has been tested through the Seeds of Life program in East Timor.

Replicated trials planted at Aileu, Maliana, Betano and Fatumaca included maize, cassava, sweetpotato and peanut. Seven seed production officers across six districts are working with a seed officer and adviser to produce bulk quantities of selected seed and 50,000 sweetpotato cuttings. The United Nations Food and Agriculture Organization has agreed to purchase, on behalf of MAF, seed produced in-country. The project team has documented that farmers are selling surpluses of staple crops introduced through the project, as evidenced by the different colours of sweetpotato varieties released when compared to local varieties. Seed dryers and seed cleaning equipment have been purchased to improve the quality for 2009–10.

New varieties of commonly cultivated food crops were introduced and evaluated in replicated trials. Included were 20 maize (mainly from the International Maize and Wheat Improvement Center–CIMMYT), 15 peanut (mainly from the International Crop Research Institute for the Semi-Arid Tropics–ICRISAT) and 16 varieties of sweetpotato (mainly from the International Potato Center–CIP), and 25 cassava clones (mainly from the International Center for Tropical Agriculture–CIAT). Within each trial were at least two local varieties. In addition to the varietal evaluations, a number of farming systems trials were installed. These included time of planting/weeding of maize trials, weevil tolerance in maize varieties, the effect of phosphorus on peanuts and a planting distance on peanut yield trial.

A seed collection curator was assigned during 2008 to collect and conserve germplasm. In the current collection are 80 cassava entries, 40 sweetpotato varieties and 30 peanut varieties. Seed of the released varieties was conserved on the research stations, both in the field and stored in warehouses.

Two East Timorese social scientists worked for much of the year collecting data and preparing reports on the economic benefits of farmers involved in SoL in Aileu, Baucau, Liquica and Manufahi. During the year cropping calendars

for SoL subdistricts in Aileu, Baucau, Liquica and Manufahi were completed and cropping calendars for new locations in Venilale, Maubisse, Natarbora and Turiscai commenced. A social science adviser from the Australian National University commenced support work with SoL in April 2009. Research to develop 'packages of technology' included experiments to test velvet bean (*Mucuna pruriens*) as a weed control in maize, weeding trials in maize, positioning of cuttings of sweetpotatoes, phosphorus application on peanuts and weevil tolerance in maize.

The level of institutionalisation of SoL into the MAF increased dramatically during the year and now funds 28 of the 39 professional staff. The Ministry also designated managers for the Betano, Darasula and Loes research stations. MAF buildings at Comoro and in the districts were used by SoL, and MAF provincial personnel were running the research program in the districts. All SoL correspondence is now channelled through MAF.

Chromolaena odorata has been recognised by the UN Global Invasive Species Program as one of the 30 worst invasive weeds worldwide. In East Timor it is now widespread and has a negative impact on cattle and goat production. Another weed, *Mimosa diplotricha,* has invaded maize crops in higher rainfall areas of the country, reducing productivity and increasing the labour required for maize cropping. A project is now providing long-term, low-cost and low technology **control for these two serious weeds** through the introduction of two main biological control agents—the stem gall fly for *C. odorata* and a sap-sucking psyllid for *M. diplotricha*. Through the project's capacity-building activities, staff of MAF and the National University have developed a grounding in the principles of biological control. They are now able to maintain insects

Mr Rob Williams, Australian Team Leader for Seeds of Life, talking to farmer Zacharias M. Gusmao about an improved rice variety (Nakroma) that Zacharias is growing as part of the Seeds of Life program.

Rebecca Andersen, a volunteer with Seeds of Life, at a farmers' field day in Liquica district.

in a low-technology setting using techniques introduced through the project. After initial community resistance and suspicion, farmers are now asking to be included in the project, with significant change in community attitudes to biological control, as evidenced when local farmers protect release sites from fires.

Ongoing development of agriculture is constrained by limited capacity. A project designed to boost both production and capacity has recognised the need to undertake this on a small scale. The approach it is taking is to **invest in micro-projects** valued between $10,000 and $35,000 and to link Timorese researchers with local agricultural producers. Australian experts are acting as mentors, providing research and development knowledge and other information to support project development and implementation.

Six micro-projects approved by the Project Steering Committee in March 2008 are nearing completion. Four of them have completed field and data entry and have commenced data analysis. Another project, led by a former ACIAR John Allwright Fellow, is working to develop a nutritional decision support system for East Timor cattle that should contribute significantly to improving cattle production.

The micro-project teams presented their preliminary research results at East Timor's 4th Annual National Agricultural Workshop in November 2008 to an audience of academics, students, MAF personnel, district livestock officers and farmer representatives, together with donors, NGOs and other ACIAR project scientists.

Cambodia

AOP budgeted expenditure in 2008–09	$1,635,144
Actual expenditure in 2008–09	$1,789,109
Expenditure in 2007–08	$1,867,363
Expenditure in 2006–07	$1,744,985

Key performance indicators	Performance 2008–09
Collaboration commenced between Cambodian research and extension organisations in ACIAR projects and the new AusAID Cambodian Agriculture Value Chain Program (CAVAC)	Under CAVAC, over 80% of the Cambodian Agricultural Research Fund small projects awarded in 2008–09 involved government extension agencies (provincial Departments of Agriculture) and/or NGOs. Of the seven large ACIAR projects active in Cambodia as of June 2009, six involve NGOs and/or extension agencies.
A new horticulture program designed in collaboration with Cambodian partners and initial activities implemented	A new major project has been designed in collaboration with Cambodian partners, with initial activities implemented through an extension to a current Cambodian vegetables project.
A new integrated project initiated addressing production constraints and value chains for rainfed field cropping systems	A new integrated project was initiated in north-western Cambodia to address production constraints and value chains for rainfed maize–soybean cropping systems. Eight village clusters were established, and 19 trials of improved varieties and production practices were successfully completed.
Suitable conditions for successful production of legume crops following rainfed rice identified in lowland environments	Legumes (peanuts and mungbeans) that can be produced successfully after rice on Prey Khmer soils (a major lowland soil) with supplementary water or full irrigation were identified.
Options to improve cattle health and production assessed by Kampong Cham farmers	Options were assessed in three provinces, including Kampong Cham, through a survey of farmer knowledge, a cattle trader survey and farmer interviews.
At least 40% of new projects designed to have significant farmer or policymaker impacts within 5 years of completion	Each of the three projects to commence in late 2009 have been designed to have significant farm-level impacts within 5 years of completion.

Position

In 2008–09 ACIAR continued to develop its program around two areas: support of applied research to help agricultural diversification, particularly for non-rice and horticulture crops and ruminant livestock; and increasing the productivity of rice-based farming systems. Increasing rice production increases food security and income, enabling farmers to invest in higher value activities such as vegetables. Yield increases also help free up agricultural land, allowing diversification. Increasing rice production and supporting diversification form the two research subprograms in ACIAR's Cambodia program, and these are complemented by a strong emphasis on building research and development capacity and creating linkages between Cambodian research organisations.

A major new initiative, the Cambodia Agriculture Value Chain Program (CAVAC), commenced in 2009. The new five year, AusAID-funded A$42 million program aims to accelerate growth in the value of agricultural production and smallholder incomes in selected provinces (Kampong Thom, Takeo and Kampot) through improved productivity of rice-based farming systems. ACIAR is managing CAVAC's Research and Extension component, co-funded by ACIAR and AusAID. ACIAR-managed work will integrate with other CAVAC components to start in mid-2009 that address agribusiness development, water management and irrigation and the business enabling environment.

Mr Long Ky Meng, a field production officer with an improved rice variety—part of the Agricultural Quality Improvement Project in Cambodia which aims to work with farmers to strengthen food security and to build a more commercial rice industry. [Photo: Brad Collis]

Achievements

Subprogram 1: Securing productivity of rice-based farming systems

Changes in Cambodia's rice system now offer its farmers in lowland areas **opportunities for diversification**. First, improved rice technologies enable them to grow more than enough rice for their family needs, so they can forgo some of the area formerly dedicated to rice production and grow a higher value crop that increases family income. Second, some of the newer rice varieties mature earlier and use less water, thus providing a longer 'window' for growing another crop to follow rice at the end of the wet season. A project is seeking to develop double-cropping options for a rice–non-rice (mungbean, soybean and peanut) system, and to promote non-rice crop technologies that are efficient users of water and promise high financial returns to growers.

The project team is monitoring continuous development of two model farms that had been developed in the first year with farmer owners—one in Kampong Thom and the other in Takeo. A third one is being developed in Kampong Cham. A major achievement so far is demonstration of the feasibility of double-cropping (rice–legume in Kampong Thom) and triple-cropping (rice–rice–legume in Takeo) using only supplementary irrigation water, mostly by hand watering.

Rice is the staple crop in Cambodia, with yield increases vital for food security and to free up land for diversification of agriculture. [Photo: Brad Collis]

Subprogram 2: Income generation and better nutrition through agricultural diversification

Village producers own the majority of large ruminant livestock in Cambodia, and up to 25% of cattle are currently exported. There is an opportunity to **increase cattle production and address rural poverty**, but progress is limited by common diseases such as haemorrhagic septicaemia, FMD, blackleg and parasites. Other limitations are poor nutritional, breeding and general husbandry and livestock management practices. A project to improve profitability of large ruminant production by smallholders is working at six project sites in Kandal, Kampong Cham and Takeo provinces, consisting of three sets of 'matched' villages. The project team is comparing the effects of introducing a 'best-practice' health and production package. As the project completes its second year, interventions in cattle nutrition, health and husbandry management, and marketing have commenced at the six project villages. Staff of the Cambodian Department of Animal Health and Production are working closely with smallholder farmers and the participatory approach is proving successful, with methodologies accepted and implemented by farmers. Some farmers are already benefiting from improved cattle productivity through increased household income and savings in labour time.

In Cambodia productivity is increasing as crops diversify beyond rice, partly in response to demand from Thailand. But the relative inexperience of Cambodian farmers in growing new crops, especially maize, presents some challenges, for example in declining soil fertility. **Appropriate agricultural management techniques and technologies** are being introduced to alleviate this decline, but must be delivered with appropriate socioeconomic considerations that cater for the whole value chain, from farms to postharvest management. A sustainable model for maize and farmer-ready technological packages are being developed and delivered to farmers through participatory methods that address relevant social and economic factors across the whole value chain.

The project is divided into eight village clusters, four in the district of Samlaut and four in the municipality of Pailin. A total of 19 trials of improved varieties, rhizobium inoculation of legumes, and nitrogen nutrition of maize have been successfully completed. Yields of maize, soybean, peanut and mungbean in experimental plots exceeded the predicted maximum yields for Cambodia and were more than double the average farmer yields. The project has identified six production technologies to help farmers increase crop yields.

A review of marketing arrangements in the Pailin area revealed that there is essentially a single buyer for upland crops in north-western Cambodia. The Northwest Agricultural Marketing Association (NAMA) has been established to help market upland crops, and already its members account for about 20% of the crop in that region.

NAMA is seeking to develop alternative export markets and establish farmer hubs for inputs, outputs and communications. NAMA is also engaging with the open source application Frontline SMS to establish an SMS Field Communication System and install a server in Pailin, with particular focus on the provision of information (rated top priority by members) and the exchange and sharing of silo association price and market information.

While most farmers in Cambodia keep cattle for draught and wealth accumulation, some can see the potential of cattle production as a source of income. But **providing feed for cattle** is a major challenge for 8 months of the year, and this problem is compounded by labour demands (up to 8 hours daily) associated with feeding cattle. A project seeks to increase cattle productivity of smallholder farmers by improving feed availability and quality throughout the year and reducing the labour requirements associated with feeding cattle.

The project is drawing on CIAT-funded work that led to the recent introduction of improved forages and fodder banks in Kampong Cham and the successful feed-year management approach developed through an earlier ACIAR project. To increase adoption of forages, the project has instituted a program of training courses, field visits and community activities. These activities have resulted in adoption of forages by farmers in six provinces, beyond the geographical scope of this project. This has largely been achieved through engaging and training over 200 farmers, together with staff of NGOs, universities and government, in the establishment, management and feeding of forages for cattle production.

CAVAC

CAVAC commenced in 2009. ACIAR will oversee the Research and Extension component. CAVAC's goal is to accelerate growth in the value of agricultural production and smallholder incomes in selected provinces (Kampong Thom, Takeo and Kaput) through improved productivity of rice-based farming systems. The Research and Extension component will:

- fund and manage programs of priority research activities that address constraints in selected value chains
- implement a farmer extension program among participating water user and agribusiness groups
- enhance the capacity of extension providers to transfer improved technologies and information to farmers
- develop and implement a partnership program linking researchers, extensionists, farmers and agribusiness
- assist in sustaining the operational capacity of the Cambodian Agricultural Research and Development Institute.

This program component will work in integration with components addressing agribusiness development, water management and irrigation, and a business-enabling environment. These other components are shortly to be tendered out for management by a contracting organisation. The ACIAR-managed component involves an internationally recruited manager, supported by four Cambodian technical specialists (one located in Phnom Penh and the other three in each of the CAVAC target provinces). In addition, the program will engage administrative and support staff.

Four staff are in place, appointed under contract, to help implement the Research and Extension component. A key priority is the continuation of the Cambodian Agricultural Research Fund (CARF), which helps Cambodian researchers develop skills in project management and development through the funding of small projects. Twenty-six proposals were received and jointly reviewed by Cambodian and international referees, with 11 proceeding to funding.

Lao PDR

AOP budgeted expenditure in 2008–09	$1,718,735
Actual expenditure in 2008–09	$1,718,050
Expenditure in 2007–08	$1,500,732
Expenditure in 2006–07	$1,207,853

Key performance indicators	Performance 2008–09
Several Lao Agricultural Research Fund (LARF) (small projects scheme) awardees using the experience in LARF projects as an entry point for involvement in national-level or donor projects	Several LARF projects have been integrated into larger national programs, including development of soybean and maize varieties and research on rice blast disease resistance. Several LARF projects collaborate with donors (CIRAD-France and Vietnam) and International Agricultural Research Centres (IRRI and CIMMYT).
Initial information on livestock movement and its potential impact on transboundary animal diseases compiled and communicated to policymakers	An information system has been designed that channels movement data through the Lao Department of Livestock and Fisheries for discussion and analysis. Initial results have been presented to regional animal movement meetings, with the FAO funding a complementary project in the region.
Significant farmer-level adoption of improved cattle and pig feed options from ACIAR projects in at least two provinces of northern Lao PDR	About 1,200 households in 12 districts of six provinces are now using legumes to feed pigs, with further scaling-out planned though government agencies and NGOs associated with the project.
Integration of ACIAR riverine and culture fisheries projects with Mekong River Commission and government programs in the region	A suite of projects have been implemented in partnership with government agencies, several of which link with the Mekong River Commission, including analysis of three Mekong fisheries databases, evaluation and adaption of fish ladders and the introduction of culture-based fisheries to local communities.

Position

ACIAR's program in Lao PDR is organised around two subprograms: identifying alternatives to shifting agriculture in upland areas; and supporting agricultural diversification in lowland farming systems. These intersect with and support the Lao PDR Government's objectives. Agriculture in Lao PDR employs more than 80% of the population but provides only 53% of GDP, leaving at least one-third of the country living below the poverty line. Seasonal rice shortages occur, making food security central to agricultural development. Capacity building for research and extension systems is also a focus, with ACIAR activities, where possible, complementing large donor programs to improve rice, forestry, and animal health and productivity.

Achievements

Subprogram 1: Alternatives to shifting cultivation in upland areas

The search for suitable forage legumes to **supplement the diets of village pigs** has led scientists to trial both fresh and dried *Stylosanthes guianensis* CIAT 184 (Stylo) to feed pigs in pens. Pigs have consistently doubled their growth rates, and there have been labour savings of at least 1 hour/day for the women who tend them. This improved productivity enabled many farmers to raise and sell more pigs each year. The availability of Stylo has encouraged many farmers to change the way they manage pigs from free scavenging to at least partial confinement in enclosures and pens. Although farmers reported improved pig growth in sow–piglet production systems, farmer experiences and research results also showed that young piglets were benefiting less from Stylo supplementation than older pigs. The research team believes that this may be related to the relatively high fibre content of Stylo (and other forage legumes and natural vegetation). Piglets have a limited gut capacity and thus depend on a nutrient-dense diet for good growth.

Cattle and buffalo in Lao PDR account for approximately 20% of agricultural production. But opportunities for smallholders to increase production and benefit from the 3% annual growth in demand for livestock meat across Asia are constrained by entrenched diseases, poor feeds and subsistence-based husbandry

A young girl and her grandmother in the uplands of Laos carrying freshly cut fodder to their village as part of an ACIAR/AusAID/CIAT livestock improvement program. [Photo: Brad Collis]

practices. A project working in six villages located in the three northern Lao PDR provinces of Luang Prabang, Houaphan and Xieng Khuang is developing a **best-practice approach to improve livestock productivity** and potentially increase marketing opportunities for smallholder livestock producers. National, provincial and district government staff members are working closely with village farmers to implement the project, along with international experts in different fields of large ruminant production.

The limitations of disease to large ruminant production have been confirmed through identification of gaps in disease diagnosis and reporting. Targeted disease surveillance has commenced at the six project sites, with FMD and haemorrhagic septicaemia identified as the major concerns to biosecurity and trade. The team has identified liver fluke disease due to *Fasciola gigantica* in adult buffalo and cattle and *Toxocara vitulorum* in calves as production diseases of concern. Implementation, testing and demonstration of intervention effects on productivity are in progress.

A Lao woman with fruits she collected from the upland forest. [Photo: Brad Collis]

Good progress has been made in a project aiming to improve the **management of zoonotic diseases** (transmissible from animals to humans) associated with pig production and pork consumption in Lao PDR. A slaughterhouse survey carried out in six districts in four provinces sampled approximately 800 pigs and found evidence of the nematode worm *Trichinella,* but the dominant species infecting pigs was found to be the dog (hydatid) tapeworm (15–30% of pigs were positive on inspection). Analysis of faecal samples from pigs at slaughter indicates that they may also be an important reservoir of the zoonotic liver fluke *Fasciola*. *Balantidium coli*, a protozoan potentially causing severe human disease, was found in 19% of pigs. During a subsequent community-level survey, farmers were asked for their knowledge about pig–human transmission of disease. Initial analysis of the data suggests that most villagers understand that people can get disease from pigs but have limited understanding of how infections are acquired.

Another project is studying the scaling-out of best-practice extension and capacity-building methods for livestock production in northern Lao PDR. The research team is helping to **adapt livestock extension approaches** to 11 targeted poor districts. Sixteen district staff from three districts have now received training in the conduct of more-advanced cross visits aimed at the specific interests of women pig farmers and Hmong cattle producers. Twelve Hmong farmers from Koun district visited Nonghet district, near the Vietnam border, to learn about cattle fattening and marketing techniques from more-experienced Hmong cattle fatteners. Twelve Lao Loum and Thai Deng women farmers from Huaphan province visited pig producers in Pak Ou district, Luang Prabang province, to learn about intensive piglet raising and fattening techniques. The project team has since trained and mentored all 24 district extension staff in following up those 48 farmers involved in the cross visits. Data on their changes in livestock numbers and management practices, forage

area, and net profit from livestock sales have been collected by district staff every 4 months during the reporting period. These same 24 livestock staff have also learnt how to write farmer case studies using interviews, digital photos and a document template.

Subprogram 2: Agricultural diversification to improve productivity of lowland farming systems

A 4-year project in Lao PDR aims to improve the productivity and profitability of the **dominant lowland rice-based system**, and to pursue diversification in suitable locations by adding non-rice crops under irrigation in the dry season. The project is extending rice technologies of adapted varieties and direct seeding to farmers, and developing agronomic packages for non-rice crops in lowlands. Farmer participation and economic evaluation of new technologies are two key aspects of the project. Farmers who had the opportunity to test a range of rice varieties mostly showed preference for different varieties to grow in upper and lower fields.

For the trial by farmers testing rice direct-seeding options there were 10 on-farm experiments in the target provinces in the dry season under irrigated conditions. Comparisons were made between different methods of direct seed establishment such as broadcasting and row seeding, and they were also compared with traditional transplanting methods. When compared with transplanted rice, broadcasting produced slightly lower yield. Row seeding, on the other hand, produced yield that was very similar to transplanted rice. The advantage of row seeding is that weeding can be readily facilitated. While broadcasting was the farmers' preferred option due to reduced resource requirements for crop establishment, this may not be suitable where weeds are likely to be a major problem.

Trials of maize (feed maize) in Savannakhet province determined that hardpan of soil in lowlands has an adverse effect on maize yield. When the hardpan was disrupted, maize yield increased significantly, from 7.2 to 8.6 t/ha.

Fish from seasonal riverine and culture fisheries is the main animal protein source of the Lao people and ACIAR-funded research is developing technology and management techniques to optimise yield.

Through this suite of projects liaison between Thai and Lao scientists continues to grow, with Lao scientists receiving training from Thai scientists.

Barriers to migratory fish movements are a key threat to the future subsistence and commercial use of fisheries resources in the Lower Mekong Basin. Increasing development of the basin must consider the potential impacts on fish passage because migratory fish form the major source of animal protein for most of the region's rural communities. In other areas of the world fish passage facilities (such as fishways or fish passages) are effectively used to maintain pathways for migratory fish in order to prevent population decline. But fish passage management guidelines are currently poorly defined in Lao PDR and other lower Mekong countries. A project is undertaking a proof-of-concept study to demonstrate the benefits of fishway construction for floodplain species in central Lao PDR. An experimental facility was installed at a floodplain regulator in Pak San. Initial experiments were highly successful, with over 2,000 fish from 50 species successfully gaining passage in the first 2 weeks. A preliminary analysis of results suggests that vertical slot fishways, on conservative gradients, could represent a useful management tool for the rehabilitation of wetland fisheries.

A Lao researcher, Viengsavanh Phimphachanhvongsod, right, with a farmer trialling forage grasses to improve his livestock production. [Photo: Brad Collis]

The Thailand Department of Fisheries has gained much recent experience with fish passage technology through previous biological assessments undertaken at Pak Mun, and traps and transport fishways at other sites of key significance in the Mekong Basin. Thai fisheries researchers are collaborating with Lao and Australian scientists to **value-add to the existing assessment of fish passage** in Lao PDR. These collaborative efforts will be used to consolidate existing work in the wider Mekong regions and develop a plan to improve opportunities for fish passage at the estimated 10,000 barriers to fish passage currently existing in Thailand and Lao PDR.

A good catch of catfish and cyprinids from the experimental site in PakSan, Lao PDR. [Photo: Douangkham Singahouvong]

An ACIAR-funded study identified a major opportunity for enhancing incomes of farmers living in the upland regions of northern Lao PDR by improving silviculture. This includes **interplanting with a tree-form non-timber forest product**, paper mulberry. A project team is now helping to improve silvicultural management of teak plantations, develop and refine agroforestry systems involving teak and paper mulberry, and implement village-based genetic improvement of teak, focusing on Luang Prabang province. So far, a range of excellent field trials has been established. The project is adapting teak silvicultural practices to suit agricultural practices and preferences

in northern Lao PDR. Incorporating paper mulberry into a mixed teak agroforestry system will realise annual incomes from as little as 2 years after planting.

Timber from the **plantations of eucalypts and teak** grown in parts of Lao PDR may be processed locally for furniture manufacture, but most timber is sold for export. Few products are made, as the Lao timber processing industry is relatively new. The majority of timber is cut down in local sawmills and exported to Vietnam and Thailand. Opportunities exist to expand Lao timber processing and manufacturing so that more value-adding can be carried out and the returns captured locally. A project is enhancing the range, quality and value of products produced from locally grown timber through the development of appropriate timber processing, the introduction of new technologies and the application of quality controls. A detailed analysis of the current capabilities of Lao furniture companies has resulted in the identification of areas for actions that will ensure the Lao timber and furniture industry becomes internationally competitive. Steps are now underway to implement improvements to production methods. The project team has produced a report, 'Implementation of recommended changes in factory layouts', as a guide for Lao furniture manufacturers. A number of companies participating in the project are now implementing the project team's recommendations.

ACIAR-funded research improving the health and production of village pigs in Lao PDR has local impacts and it also helps reduce the threat from trans-boundary diseases in the Mekong area. [Photo: Brad Collis]

Lao Agricultural Research Fund

In Lao PDR funding support for agricultural research is external and directed to large projects. There remains a funding gap for smaller projects, particularly for recently graduated agricultural scientists and those returning from study overseas. The Lao Agricultural Research Fund (LARF) is helping to fill this gap by **funding small research grants** aimed at building and maintaining career momentum for scientists. The project also includes a training component, with training initiatives in research proposal development, technical writing skills, biometrics and English.

During the period October 2008 to February 2009 opportunities were provided for Lao scientists to develop and submit research proposals of 1–3 years' duration, with a project budget limit of US$12,000 (but with the budget for any single year not to exceed US$5,000). Areas of research proposed for funding include: crop production; livestock production; fisheries research; forestry systems research; natural resource management; integrated agricultural systems research; and economic and socio-economic studies relating to agricultural production.

Thailand

AOP budgeted expenditure in 2008–09	$500,937
Actual expenditure in 2008–09	$377,872
Expenditure in 2007–08	$526,597
Expenditure in 2006–07	$542,659

Key performance indicators	Performance 2008–09
Initial farmer trials to improve yield and reduce weed infestation of rainfed rice completed in north-eastern Thailand with World Vision and university collaboration	2008 season trials were completed in Maha Sarakham province through collaboration between farmers, World Vision and Khon Kaen University.
Training visits completed between Thai and Lao partners in two ACIAR projects	Training visits were completed for two fisheries projects and a rice-based farming systems project.
Initial training completed of Thai research and quarantine workers in plant pest and disease diagnostics, using a range of molecular and traditional diagnostic techniques	Training workshops in traditional taxonomy, molecular diagnostics and surveillance were held at the Department of Agriculture in Bangkok. A new laboratory for molecular diagnostics for quarantine purposes was also established.

This marine finfish farmer in Socun, Southern Thailand, is benefiting from improved hatchery and grow-out technology that is being adopted across the Asia-Pacific region.

Position

In 2008–09 ACIAR's program with Thailand continued to shift towards a co-investment partnership as Thai organisations' engagement with a wider range of Australian agencies increased. This reflects Thailand's transition as its economy and research capacities grow. ACIAR's program focuses on: implementing the results of earlier projects with relevance to poor farmers; scientific and policy exchange on biosecurity systems implementation; and research to build on joint endeavours to reduce and eliminate international agricultural protection and subsidisation.

Achievements

In Thailand work is underway in a project designed to improve both **diagnostic skills and capability for plant quarantine**. In the case of taxonomic training, two Thai scientists have trained in Australia in areas of specific interest to plant quarantine: the identification of exotic nematodes and the identification of exotic fungi and bacteria associated with export seed. Follow-up workshops in Thailand help reinforce skills by allowing Thai scientists to apply techniques in their own laboratories. Molecular training is the most intensive component of the project, with four Thai scientists being trained for a period of 3 months in Australian laboratories each year. Again, training is in specific areas that relate to pests of important industries in Thailand, including molecular diagnostics for fruit fly, citrus canker, black spot, potato spindle tuber viroid and general virus detection.

The concept of remote microscope diagnostics (RMD) is attractive because it allows non-experts in remote locations to interact with diagnostic experts in real time to identify a pest specimen. Of immediate application to insect identifications, RMD uses the internet to connect a microscope to a computer in another location. Microscope equipment and RMD hardware has been purchased, assembled and tested in Australia prior to being installed in Thailand. A workshop will be held later in 2009 to install the equipment and to train Thai staff in its use.

Maha Sarakham province in north-eastern Thailand is one of the poorest parts of the country. In a region that suffers from low soil fertility, salinity and acidity; the major sources of income are rice grown under rainfed lowland conditions and cattle rearing. A project linked with World Vision is helping farmers in the region to **improve the reliability of their rice-based farming systems** and lift income by increasing cattle production with better livestock management practices. Project work this year has focused on teaching the target farmers techniques of row seeding and pre-rice mungbean cropping, prior to the transplanting of the wet-season rice crop seedlings. The project advisory team and experts from the rice research centres have also conducted training sessions. In the area of cattle production the farmers learnt about introduction of forage grasses, and trials of Purple Guinea, Nebiar, Mulato and Pangola grasses for forage got underway. The forages were then fed to cattle and processed to preserve as feed in the dry season. Participating farmers report that they are very satisfied with the program. They have learnt much, and wish to expand their cultivation areas to respond to the needs of their own cattle and to sell cattle for additional income.

Burma

AOP budgeted expenditure in 2008–09	$140,292
Actual expenditure in 2008–09	$140,292
Expenditure in 2007–08	$0
Expenditure in 2006–07	$203,325

Key performance indicators	Performance 2008–09
Introduced legume varieties and management practices showing increased yields in farmer and research station trials	More than 60 on-farm and research station trials have introduced a range of promising varieties of peanut, pigeonpea and chickpea. Use of legume inoculants and better crop management practices have significantly increased crop yields.

Position

ACIAR's program in Burma supports multilateral collaborative research projects to improve food security and nutrition. This is done either directly or through support of farmers' cash incomes. Particular regard is given to the humanitarian needs of Burma to align the ACIAR program with the focus of the Australian aid program in Burma. Development of new projects has been on hold in recent years in recognition of the current international situation. One ongoing project on legume cultivation in Burma's central dry zone was active in 2008–09.

Researchers looking at new crop varieties being tested in Burma.

Achievements

In the central dry zone of Burma a project led by ICRISAT is identifying and distributing **high-yielding chickpea, peanut and pigeonpea** suited to the zone. In the past year the project has substantially covered the prescribed milestones for these three legume crops in the Sagaing, Mandalay and Magway divisions of the zone. Farmers participated in varietal selection trials, finding pigeonpea varieties that conformed with their preferences, looking for highest yield but also were drawn to one line with attractive seed colour. In chickpea most of the kabuli varieties had high incidence of dry root rot compared to the desi varieties, and the farmers expressed their desire for early maturing varieties with resistance to dry root rot. One chickpea variety stood out in the Sagaing division; farmers have already started seed production of this variety and it now grows on 100 ha. By growing this variety farmers have achieved 30–50% higher productivity and resistance to diseases.

ACIAR project staff measuring rodents in Burma, where new management techniques are helping reduce the damage rodents cause to crops.

Soil analysis from research stations and farmers' fields revealed deficiencies of available iron, zinc, sulphur and organic matter at all project sites in the three divisions. Field experiments to determine the role of seed priming in enhancing crop productivity found that a 4-hour soaking of pigeonpea seed was optimum, resulting in good germination, plant establishment and growth. However, seed-priming trials in chickpea revealed no significant differences in terms of germination percentage or plant establishment.

Farmers across the three divisions have established village seedbanks to build up supplies of the new preferred varieties of chickpea and pigeonpea. As well, peanut farmers in a Magway township who had seen the performance of Sinpadetha 8 peanut variety during the rainy season are undertaking seed multiplication of their own. Ten farmers in this township have formed a Seed Committee to take up groundnut seed production activities for the coming seasons.

Inoculation with the root bacterium rhizobium has the capacity to lift production through the supply of nitrogen to the plant. New equipment has strengthened the capacity of the research unit at the Department of Agricultural Research, Yezin, to undertake rhizobium inoculation, and trials have successfully taken place at all project locations. Workshops in legume production and rhizobium inoculation technology have accompanied the trials.

South Asia

Nasima, from Bangladesh, lost her husband in Cyclone Sidr in November 2007. She and other farmers in the Babu Ganj district near Barisal in Bangladesh are involved in an ACIAR project encouraging growing of alternative crops in their fallow rice paddies to boost incomes and reduce poverty. Nasima's wheat crop yielded 3.7 t/ha, and she sold the surplus wheat and mung beans to earn a modest profit for her family.

Financial year	Regional expenditure (A$)	Percentage of total project expenditure	Commission target as percentage of expenditure
2008–09	8,453,522	19.5%	< 15%
2007–08	4,745,256	12.5%	< 15%
2006–07	5,933,376	15.1%	< 15%

India

AOP budgeted expenditure in 2008–09	$2,968,839
Actual expenditure in 2008–09	$2,792,556
Expenditure in 2007–08	$2,136,761
Expenditure in 2006–07	$2,411,093

Key performance indicators	Performance 2008–09
Activities addressing yellow rust strain Ug99 and water-related abiotic stresses (drought tolerance, waterlogging) implemented as part of the new collaborative program on marker-assisted breeding wheat	The Indo–Australian Program on Marker-Assisted Wheat Breeding was successfully implemented, addressing key biotic and abiotic stresses that are high priorities for India and Australia. The program is underpinned by a unifying system to maximise sharing of genetic information among participants.
An integrated cluster of linked projects designed and implemented around sustainable watershed development and water resource management in Andhra Pradesh	As planned, two new cluster projects were implemented in 2008–09 and a further two are under design for a 2009–10 start.
Next generation resource-conserving technologies based on zero-tillage and residue retention developed and tested on farmer fields in the rice–wheat areas of north-western India	Two projects developed and tested next generation resource-conserving technologies on a large number of farms in two states, with high-yielding wheat crops planted with zero-till equipment into heavy rice straw. Direct-seeding technologies for rice on station and on farmers' fields have averaged yields of 8 t/ha.
Principles of farmer participatory soil fertility management and water harvesting techniques refined and applied by key NGOs	Working through Pradan, an Indian NGO, in the village of Amagara, better soil and water management of vegetable production resulted in a sixfold increase in the 2008 monsoon season compared with 2 years earlier.
Assessment of India's domestic agricultural regulatory frameworks and scope for beneficial deregulation and associated reforms	Competition and regulatory reform requirements in India to facilitate efficient agricultural markets were assessed, with linkages to key government agencies being operational.
At least 40% of new projects designed to have significant farmer or policymaker impacts within 5 years of completion	Four of the six projects which began operations during 2008–09 were designed to have significant impact on policymakers or farmers within 5 years of completion.

Position

India faces significant challenges in its rural sector, with most of the country's 300 million poor and undernourished people living in rural areas. Opportunities exist as India embraces trade liberalisation to create a policy environment for reform of the agricultural sector. This, linked with India's large and well-developed national agricultural research system, and the Indian Government's desire for a more tightly focused suite of projects, offers the chance to focus ACIAR projects to areas of greatest need.

Australia's aid program in India has reduced in size, focusing on particular areas of need agreed between the two countries. ACIAR's program is focused around three subprograms: the Indo–Australian program on marker-assisted breeding of wheat; water management for enhanced livelihoods in rainfed areas of the Central Plateau; and policy options for trade and market reform for agribusiness development. The first subprogram is delivered through a joint 5-year program co-funded by the Indian Council for Agricultural Research and ACIAR.

Achievements

Subprogram 1: Application of marker-assisted selection as a tool in wheat breeding (Indo–Australian program on marker-assisted breeding for wheat)

India urgently needs **efficient new wheat cultivars** with increased yield and rust resistance to lift production. Current research is focusing on development of resistance through the application of molecular technology. India possesses many of the necessary research skills and infrastructure, and Australia is assisting to facilitate the cohesive linkage of the components to breeding, while targeting an array of stem, leaf and stripe rust gene combinations. Components of the research include the use of genetic markers to plot the presence of key genes in breeding populations. Australian germplasm sent to India in the first year of the project has been crossed with Indian parents and progeny are under development. Key parental materials have been profiled, with markers at laboratories in India and Australia. The first shipment of Indian materials arrived in Australia late in 2008, and crosses have been made between Indian and Australian lines under quarantine conditions. Progress is being made on the establishment of a database describing the genetic characteristics and performance of advanced lines. The research under the Indo–Australia program is also addressing the problems of waterlogging, salinity and element toxicities on stem rust (Ug99), along with drought tolerance.

Another project is focusing on **improving farm profitability in north-western India** (particularly in Haryana) by improving the grain quality of the wheat produced. Researchers are identifying practices that farmers can adopt as part of an integrated system for enhancing both quality and wheat yield. Development of a production and marketing culture that recognises and rewards quality attributes is also being investigated. The field demonstration and research components of the project reach into crop rotational sequences involving cotton–wheat, sugarcane–wheat, pearl millet–wheat and cluster bean–wheat; this is a significant expansion, given the past focus of on-farm research in Haryana on the rice–wheat cropping system.

ACIAR-funded research has contributed to the development of the 'Happy Seeder', an implement capable of direct drilling wheat into heavy rice residue loads without prior burning. Another new project focuses on environmental policy **issues associated with rice residue burning**

Australia's Minister for Foreign Affairs the Hon Stephen Smith MP (centre), with Dr Kuhu Chatterjee, ACIAR's South Asia country manager, and Dr Christian Roth, former ACIAR Research Program Manager, at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India.

and the role of the Happy Seeder in addressing these issues. As part of the project, researchers are assessing the broader significance of agriculturally-based pollution in Punjab. Progress has been made to identify technically feasible on- and off-farm alternatives to crop residue burning. The Happy Seeder continues to be refined, with development of a sixth prototype that is suitable for sowing crops other than wheat into rice straw residue. This machine can manage sowing for rice straw loads of up to 10 t/ha, and has also proven effective in sowing mungbean into wheat straw residue. Three methods of planting rice have been proven: broadcasting of direct-seeded rice on unpuddled soils, direct seeding using zero-till planters, and mechanical transplanting on unpuddled soils, the last of which is undergoing rapid adoption by rice farmers in Haryana and Punjab.

Traditionally, smallholder farmers in Madhya Pradesh use manure to fertilise their crops, but this is insufficient to provide enough **nutrients for maximum soybean and wheat productivity**. Research has been underway to overcome this nutritional deficit with a series of experimental approaches. Omission trials (where one plant nutrient at a time is omitted from the fertiliser mix) were used to identify nutrients limiting the productivity of crops, thus informing the development and evaluation of fertilisation regimes to address the nutrient deficiencies identified. A high level of engagement with local smallholders has helped to develop agronomic practices acceptable to farmers. All experiments have been conducted on farmers' fields, and farmers' field days have regularly been conducted in order to understand their perceptions of the work. The researchers demonstrated that, with the addition of an inorganic fertiliser containing identified missing nutrients, substantial benefits could be gained from a smaller manure application (5 t/ha instead of the 20 t/ha used previously), permitting farmers to treat a larger area with manure each year. For the soybean crop the treatment consists of 50% inorganic fertiliser plus 5 t of farmyard manure plus rhizobium (a nitrogen-fixing bacterium), while the wheat crop receives 75% of the recommended rate of inorganic fertiliser. Even at this reduced rate of application (5 t/ha), there is insufficient farmyard manure for application

to all of the cropped area, and in this instance the researchers have developed an inorganic fertiliser regime termed Balance Fertilisation.

Subprogram 2: Water management for enhanced livelihoods in rainfed areas of the Central Plateau, with emphasis on Andhra Pradesh

Small farmers in watersheds of the East India Plateau stand to benefit from studies of **water harvesting and better cropping systems**. A project, working in conjunction with the NGO Pradan, is using participatory action research in developing principles and testing improved practices for watershed development (WSD) for this high-rainfall plateau. The villagers have participated in an action learning cycle (plan, do, observe, reflect) that has guided the overall project as well as most activities. The project has evolved to introduce a village core committee (VCC) comprising self-help group representatives to improve project implementation and build social capacity. Ownership, responsibility and control have shifted from the team to the villagers. In Pogro village the VCC oversaw (with project support) the initial implementation of the WSD plan during the dry season. Initial implementation focused on part of the watershed, including a 'learning cluster' of six families as a focal point for the whole village and surrounding communities. In Amagara village a linear study of land use over time has revealed significantly increased cropping intensity and crop diversity.

WSD programs have been significant in raising productivity and incomes in rainfed areas of India. In WSD programs **technical water-harvesting solutions** range from simple check-dams to large percolation and irrigation tanks, and from vegetative barriers to contour banks. Field experience, however, has shown that in a significant proportion of cases the farmers/villagers show low enthusiasm for adopting WSD technologies, and failures are common. Two projects are underway to enhance the livelihoods of farmers on the Central Plateau (particularly Andhra Pradesh) by improving the institutional and biophysical performance of WSD programs. These projects have, with the assistance of the Andhra Pradesh Department of Rural Development, established a sampling frame for assembling case data.

Pearl millet stover (green matter) is a major component of ruminant diets in the crop–livestock systems of the driest rainfed parts of India. Here, pearl millet (*Pennisetum glaucum*) is the only reliably productive cereal, and a project aims to use both marker-assisted and conventional plant breeding to **genetically increase the nutritive value of pearl millet stover**. So far, the research has successfully linked laboratory quality traits for pearl millet stover with livestock productivity measurements. Having established the link, the team is making steady progress in establishing how individual and combined genomic regions (quantitative trait loci) determine in-vitro stover quality and in-vivo animal production, and in producing hybrid parent lines with enhanced stover quality suitable for use in commercial hybrid seed production.

Subprogram 3: Policy options for trade and market reform to underpin agribusiness development

Recent ACIAR research on trade reform and Indian agriculture found that trade policy reform must be complemented by 'behind-the-border' domestic reforms in order to meet government objectives of improved productivity, higher rural employment and incomes, and enhanced food security. A follow-on project now focuses on facilitating the **development of agricultural policy settings** that will enable Indian farmers to efficiently adjust to a less-regulated marketing environment. Project researchers have compared agriculture policy settings in Brazil, Russia, India, China and South Africa. Using these comparisons and a public policy framework, they are preparing to undertake industry case studies that examine the application of current policy settings at the industry level, and how an alternative competition policy regime would apply.

Other projects

A project to **increase the productivity of cattle with rumen fungal treatments** aims to improve the nutritional status among the rural poor by increasing the availability of milk in the diet. Such treatments encourage greater use of crop residues for milk production by large ruminants in smallholder units in India. Two treatments have been developed for improving the intake of poor-quality herbage by cattle. One involves the use of a nutritional supplement (organic sulfur compounds) to selectively enhance the fibre-degrading activity of anaerobic fungi in the rumen, and the other is a living fungal inoculant. Positive responses in milk production were achieved when cows received the organic sulfur compound known as MPS. During the project Indian scientists were trained in rumen microbiology, and a laboratory that is equal to the world standard for the field was equipped.

Research is progressing in a project to **improve post-rainy sorghum** varieties to meet the growing grain and fodder demand in India. Sorghum grown in India in the post-rainy (Rabi) season relies on residual soil moisture, and the crop is commonly exposed to terminal drought stress. But there is a ready market for its high-quality grain and stover (used as fodder on dairy farms). Steps to improve productivity while maintaining quality offer an attractive opportunity for sorghum farmers to improve their incomes. Genetically improving the efficiency of sorghum is a prime target to maximise grain/stover production and quality of Rabi sorghum. This project is working to improve the genetic efficiency of sorghum through the application of DNA sequences known as quantitative trait loci (QTLs) to use stored soil moisture. Genetic marker-assisted introgression of stay-green QTLs into sorghum lines is being introduced, enhancing both the quality and quantity of grain/stover of post-rainy sorghum.

ACIAR's wheat breeding program in India is based around the application of marker-assisted selection as a tool to achieve greater efficiencies. It is focused on rust resistance, abiotic stress and grain quality.

Another project has increased awareness of the need for **better management practices (BMPs) in shrimp farming** and contributed to its promotion in the Asia–Pacific region (in countries such as Australia, Indonesia, India, Vietnam and Thailand). The project has created a robust regional mechanism for networking and exchange of information. It is specifically focused to benefit small-scale shrimp farmers in Asia by helping them to reduce disease risks, improve yields, produce quality shrimp, access better markets, address socioeconomic sustainability and comply with international principles. A dedicated BMP website in the Network of Aquaculture Centres in Asia-Pacific (NACA) webpage has provided a platform for project partners and other BMP projects in the region to communicate and share information. The visibility of BMP programs has increased significantly in the region and, as a result, more and more NACA member governments are requesting NACA and other donors to establish BMP projects in their countries (e.g. Malaysia, Sri Lanka and Bangladesh).

High-value harvest from saline groundwater

Salinity is a growing threat to crop productivity across many millions of hectares in India and Australia. Farmers strive to maintain production through management options such as pumping up the saline groundwater. But often they are

Women famers from Pogro village, India, in a team building workshop as part of an ACIAR-funded research project.

fighting a losing battle, and large tracts of land formerly used to grow wheat and rice have become barren.

But from crisis often comes opportunity, and in this instance it comes in the improbable form of inland aquaculture. An ACIAR project has helped find a use for the saline wastewater, turning it into a resource to grow high-value foods such as prawns and fish.

In India a successful industry cultivating giant freshwater prawns was already operating at coastal sites (the prawns need saline water to breed). The project team of Indian and Australian scientists could see the potential for a parallel industry using the saline water thousands of kilometres inland in Haryana state. However, although the groundwater is saline, it has a different chemical profile to seawater. The two major significant differences in the groundwater are lower levels of potassium, which affect prawn growth, and higher levels of calcium, which can be fatal to larvae.

Thus, the major hurdle identified was to establish the optimum chemical balance of the groundwater for hatching and growth. Tests at the research centre in Haryana determined that adult prawns can grow quite satisfactorily at lower potassium levels provided the sodium levels were not too high. But that still didn't help with the breeding—virtually all the larvae still died soon after hatching.

Further water analysis identified an imbalance in the ratio of calcium to magnesium in the groundwater. The solution lay in filtering out the excess calcium. Although a little of the magnesium was also lost, the team could add more of this trace element to restore it to a level that mimics seawater. For the first time ever the scientists achieved successful breeding of freshwater prawns to post-larval stage in inland saline water.

This is a great encouragement for an infant industry. Inland growers now have a local enterprise that promises to supply postlarvae for stocking their ponds. Another innovation, the introduction of polyhouses over breeding ponds, is protecting the broodstock from temperature extremes in both summer and winter and helping to ensure their year-round survival. The research teams are now turning their attention to promoting other species such as carp or catfish to complement the prawn season.

Pakistan

AOP budgeted expenditure in 2008–09	$2,141,454
Actual expenditure in 2008–09	$1,960,521
Expenditure in 2007–08	$1,892,915
Expenditure in 2006–07	$1,708,789

Key performance indicators	Performance 2008–09
Innovative approaches to agricultural extension being piloted in the broadacre cropping, horticultural and dairy sectors underpinned by the development and dissemination of consolidated technology packages	Technology packages were developed through broadacre cropping projects and dairy, citrus and mango projects, and piloted using a number of innovative approaches, including NGO partnerships and a 2 year pilot program involving 200 smallholder farmers in two areas of Punjab state.
Results of policy analysis in the horticulture sector influencing government policymaking	Analysis has influenced Pakistan Government policymaking for mangoes and citrus, with draft standards developed for nursery trees and nursery hygiene, and a commercial mango export trial to China used to test a newly agreed free trade provision, along with development of a formal cool-chain and marketing system.
Framework for monitoring and optimising irrigation water management developed with key stakeholders in the Lower Chenab basin	The project has been extended after delays due to extensive staff changes and security problems restricting travel.
At least 40% of new projects designed to have components leading to significant farmer or policy impacts within 5 years of completion	No new projects were developed or implemented in Pakistan in 2008–09.

Position

ACIAR's program in Pakistan has focused in the past on natural resource management issues such as water use, salinity, drainage and tillage options for irrigated crops. This program has expanded under the umbrella of the Australia–Pakistan Agriculture Sector Linkages Program (ASLP), which ACIAR is implementing on behalf of AusAID. Through the ASLP, research has been initiated to enhance productivity in the horticulture sector, focusing on Pakistan's key crops, especially citrus and mango, and on the dairy sector, as Pakistan is a leading milk exporter. Ongoing research into the sustainability of water and land, encompassing community-driven water allocation and drainage management as well as irrigated cereal production and horticulture, complement activities under the ASLP.

The Australian Minister for Foreign Affairs has agreed, during a recent visit to Pakistan, to extend ASLP activities until 2011. This follows an external review that praised the program, noting that linkages within Pakistan between research institutions, and across the public and private sectors, as well as between Australian and Pakistan partners, were a feature of the success to date. The external review of the first phase of the ASLP found that it 'proved to be a very high-profile engagement achieving a level of recognition well above what would have been expected for its modest scope and budget'. The design used was deemed to be effective and strategically appropriate, addressed significant agricultural opportunities for Pakistan, and provided significant benefits for Australian agricultural industries.

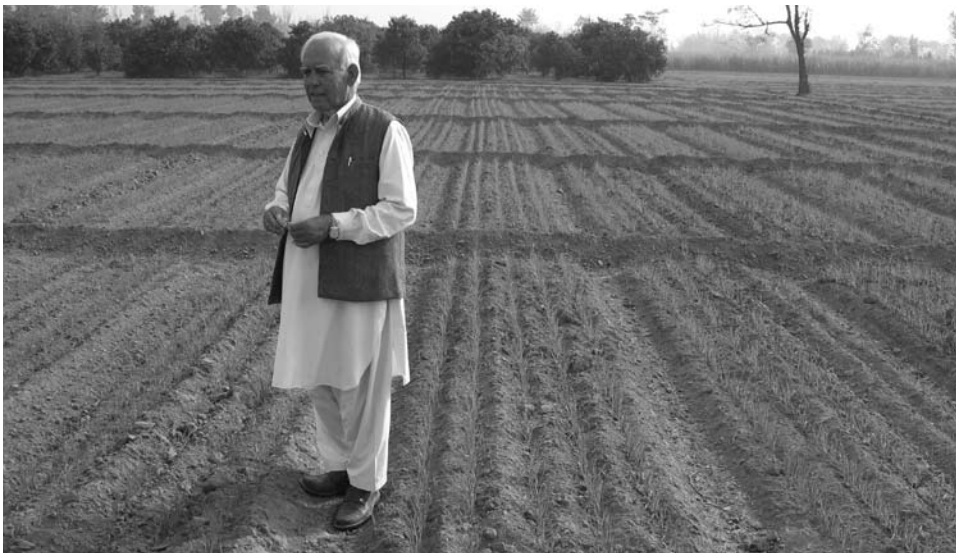
Achievements

Subprogram 1: Developing more productive and competitive mango and citrus production and marketing systems

There are four areas of focus in the ASLP **mango production project**. These are: establishment of clean nurseries; improvements in orchard husbandry; detection and management of mango sudden death; and improvements in training and extension. During the first year of the project, operations centred on establishment activities, with structures at the Mango Research Station at Shujabad in Punjab and another at the Sindh Horticulture Research Institute at Mirpurkhas in Sindh refurbished as functional research nurseries. Private commercial nursery operators have been encouraged to establish model commercial nurseries in each of the two main mango production regions of Punjab and Sindh. Other operators could learn from these nurseries and duplicate them in their establishments. One private commercial nursery operator from Multan visited Australia and received training through a Crawford Fund training fellowship. He has now commenced construction and establishment of the model commercial nursery in the Multan area.

Much of Pakistan's fruit and vegetable production, including mangoes, is not fully utilised, due to poor harvesting, handling and other postharvest practices. A project is addressing key constraints currently limiting the **efficiency, effectiveness and competitiveness of supply chains for Pakistan mangoes**, examining ways to improve and maintain mango quality from harvest to consumption. The project is identifying present market needs and likely future opportunities for Pakistan mangoes, through analysis of existing supply chains and the development of improved supply-chain management systems and practices. Experiments have addressed the issues of optimum storage, ripening procedures, assessment of harvest maturity and identification of postharvest diseases for the two main commercial mango cultivars (Chaunsa and Sindhri). Along with these trials a hot water treatment (HWT) assessment, which was not in the original plan, also took place to facilitate mango export to countries that require HWT disinfestation. In 2007 China was identified as a potential market for Pakistan mangoes. In September 2008 two groups of four final semester undergraduates of the University of Queensland's Agribusiness program took 40 kg of Pakistani Chaunsa mangoes to Beijing and Guangzhou to evaluate the market response. Their findings are being used as the basis for a commercial trial shipment to China.

Pakistan has set an annual export target for citrus of 500,000 t within the next 5 years, and $300 million in export earnings by 2013, but some key constraints need to be addressed to achieve these ambitious targets. A project aims



One of the project staff, Mr Khan, at a trial farm in Mardan, Pakistan.

to **improve mandarin and orange productivity** in Pakistan and Australia through improved nursery production practices and production; demonstration of best-practice orchard management; and enhanced research, extension and production capacity of Pakistan citrus institutions and industry.

Although hampered by the security situation in Pakistan, work has continued. The Australian citrus team has prepared an irrigation and nutrition program for a drip and sprinkler system in Pakistan. Fact sheets about the new varieties and rootstock have been prepared and a phenology calendar (describing the year-round climatic and seasonal changes affecting citrus) will be ready after the completion of the current growing season. Four staff members from various collaborative institutes in Pakistan visited Australian and received training in plant propagation and nursery techniques, irrigation systems, tree pruning and thinning, basic nutrition and other research techniques.

Research to improve orchard management techniques and more efficiently utilise inputs, like fertiliser, is increasing citrus productivity in Pakistan.

Subprogram 2: Improving livelihoods for dairy farmers

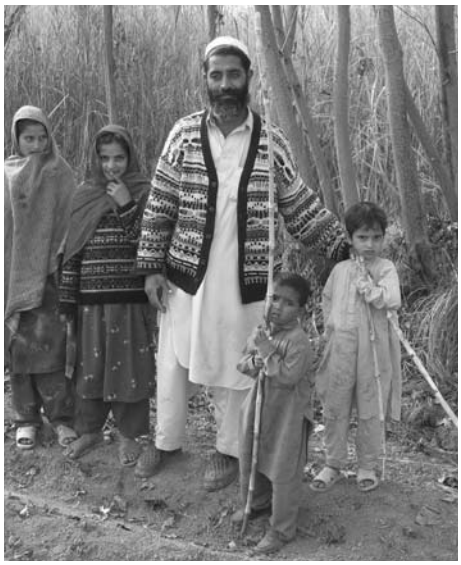
In spite of the importance of the dairy industry to Pakistan's economy and food supply, the productivity of buffalo/cows owned by smallholder farmers dependent on an income from three to ten head is poor by world standards. Much of the technology required to boost efficiency is available but is not readily disseminated nor adopted by the farming community. A project is demonstrating the economic and social benefits of **improved extension services to smallholder dairy farmers**, and also collecting, enhancing and

disseminating knowledge relevant to smallholder dairy systems. A baseline longitudinal survey is providing information on existing farm practices, feeding regimes, milk production and husbandry practices across 200 farms. Training has been provided for field extension workers and cooperating farmers, who have been introduced to the principles of feed and water management, cow health, calf rearing and reproductive management. The longitudinal survey has allowed the project team to monitor the impact of change in farming practices on productivity and farm income. The results of this survey will be important in providing a benchmark for future operations.

Subprogram 3: Management of land and water resources to sustain productive enterprises

The practice of irrigated maize–wheat cropping on permanent raised beds (PRBs) has been shown to save water and increase yields in Pakistani conditions. A project has sought to **optimise the raised bed system**, focusing on soil management and impacts caused by the new system, and the best-bet technology for raised beds, including low-cost machinery. Research has been underway since 2004, and two manufacturers are now producing quality replicas of the Australian PRB bedformer/renovator and no-till seeder, and other manufacturers are presently being courted. Analyses of all the research and farmer-demonstration data from Mardan confirm earlier findings in both the type and magnitude of improvements derived from PRB farming.

The Punjab Irrigation and Drainage Authority operate and maintain one of the largest irrigation canal systems in the world. However, the system now requires major rehabilitation and improvement to meet present-day demands. Recent analysis shows that the inequity of water distribution between head-enders and tail-enders is closely correlated to decreasing yields and increasing salinity with greater distance from the canal. Identifying opportunities for **equitable distribution of canal water and groundwater** to improve livelihoods through maximising crop production and managing salinisation in irrigated landscapes is underway. The project team is developing the hydrologic–economic modelling tools capable of scenario analysis of water distribution as a function of the crop–groundwater–soil mix—at the farm level and also at distributary and minor canal levels—a first in Pakistan. Remote sensing tools and hydrological data are being coupled with socioeconomic data to develop surface water and groundwater supply-and-demand management options at various spatial scales, to tailor water sector adaptations to changing water regimes.



A Pakistani family in their field

Bangladesh

AOP budgeted expenditure in 2008–09	$996,103
Actual expenditure in 2008–09	$1,036,971
Expenditure in 2007–08	$508,865
Expenditure in 2006–07	$481,224

Key performance indicators	Performance 2008–09
Implementation of a cluster of projects delivering a tested suite of winter-season cropping options to intensify or diversify rice-based cropping systems in southern and north-western Bangladesh	An integrated project cluster has focused on rice intensification and constraints to maize, lentil, chickpea, mungbean, mustard and wheat production during the winter season, specifically addressing winter maize production in Bangladesh.
Active partnerships established with major NGOs in Bangladesh to facilitate adoption of more profitable and sustainable winter-season cropping options	Use of the Seed Multiplication Trial concept has resulted in expansion of cropping near the trial sites.

Zero-till wheat trials, Bangladesh.

Position

Bangladesh's agricultural sector is dominated by rice production. Winter (Rabi) season cropping presents opportunities to both intensify and diversify rice-based cropping options. ACIAR research is focused on identifying and overcoming agronomic and biotic constraints to the production of broadacre grain crops, particularly those grown in the Rabi season. The potential to use legumes as a component of cropping systems is important to this research. This research focus on broadacre crop production will broaden with the emergence of rice–maize as an important cropping system.

Achievements

Smallholder farmers from South Asia and other parts of the world use **two-wheel tractors as the main means of land preparation** and other farm operations. Until now, no commercially available versatile seed drill existed for these tractors. An ACIAR project has tested seven seed drills fabricated by a New South Wales agricultural implement manufacturer—five of the tine type on a tool bar frame (modelled on the original CIMMYT two-wheel tractor seed drill) and two modified from a Chinese rotary tillage seed drill. Both types were successfully tested on most crops in farmers' fields in north-western Bangladesh, generating considerable farmer interest.

The increased availability of short-season (60–100 days), well-adapted wheat varieties bred by the Bangladesh Wheat Research Centre, and mungbean varieties which mature in 60 days, have contributed significantly to southern farming systems in Bangladesh. **ACIAR-funded research on wheat** has manipulated variables, including time of sowing, crop nutrition and irrigation, to optimise yield and resource use. Trials undertaken during 2007–08 indicated that one irrigation 20 days after sowing was the most efficient use of limited water resources, increasing wheat yield by 0.7 t/ha compared to three irrigations (with 100 kg/ha of nitrogen applied in both instances). Analysis of the results indicates that the response relates to increased mobilisation of applied nitrogen and associated improved development of adventitious roots and tillers. Recommendations for wheat production in southern Bangladesh have been changed in light of these findings and now differ from those in the north, where at least three irrigations are required for successful wheat production. Analysis of records of groundwater level at key locations across the south suggest an underused resource—the watertable is high, having the potential to contribute significantly to wheat production through capillary rise. This effect is minimal further north in Bangladesh, where the water table is much deeper.

North-western Bangladesh, the poorest region of the country with regular food shortages and dietary imbalances, grows few pulse crops such as chickpea, lentil, mungbean and black gram. A project is instituting a targeted program to **increase the production of chickpea and lentils** in this part of Bangladesh, to enhance income generation, improve human health and contribute to cropping system sustainability. Experiments with chickpea to determine optimum soil moisture level for seedling establishment, effect of mulching with strip tillage, optimum seed and phosphorus rates with strip tillage plus other factors were successfully conducted. In northern districts, yields from most of the 35 lentil demonstrations were around 1 t/ha, with low yields attributable to excessive soil moisture and use of strip tillage.

The IRRI–CIMMYT joint project 'Sustainable intensification of rice–maize production systems in Bangladesh' started in November 2008. This is separately reported in the 'Multilateral program' section.

Other South Asia and Middle East countries

AOP budgeted expenditure in 2008–09	$1,070,716
Actual expenditure in 2008–09	$2,663,474
Expenditure in 2007–08	$206,716
Expenditure in 2006–07	$1,332,270

Bhutan

Key performance indicators	Performance 2008–09
Best-practice citrus management grower demonstration trials established in Bhutan and being used for technology transfer activities	Grower demonstration trials have been established in three districts and have been used in training activities on citrus canopy management, soil nutrition, crop phenology, leaf sampling, tree reworking and crop sanitation procedures.
Agro-ecologies for wheat production in Afghanistan defined and used as the basis for dissemination of improved wheat varieties and agronomic practices	Maps depicting the relative dependence of the different provinces on irrigated versus rainfed ecologies used in project management. The maps are supported by documentation of the predominance of either; winter wheat, spring-sown spring wheat or autumn-sown spring wheat, in addition to key climatic factors (of which temperature predominates).

Implementing improved on-farm management practices for mandarin orchards in Bhutan and Australia has reduced losses from pests and diseases and increased production.

Position

ACIAR has a small program in Bhutan, reflecting the country's limited capacity to effect significant change across many agricultural sectors at one time. In addition, Australia's research expertise does not match all sections of agriculture practised in Bhutan. Activities are focused around improving citrus production, which is Bhutan's largest horticultural export industry. This includes pest and disease management, and a small initiative on water and land management.

Achievements

Mandarin production in both Bhutan and Australia could be improved through the implementation of on-farm best management

Children holding spikes of harvested wheat from a CIMMYT/ICARDA improved line, Mazar-Al-Sharif, Afghanistan. [Source: ICARDA]

practices. A project launched in Bhutan in 2007 continues to progress towards its aim of **increasing sustainable yield of quality mandarins**. Four demonstration orchards were monitored over the 12-month period for responses to pruning, the addition of chemical fertilisers and the effectiveness of pest control measures. Initial response by citrus trees to various levels of pruning has been very positive, with the full effects to become apparent over the next 12 months. Gibberellic acid, a plant hormone which is used to delay mandarin rind ageing to prolong the harvest season and help the fruit better withstand postharvest handling practices, has been trialled at two of the demonstration orchards. Initial results have been positive and formal research trials will be undertaken during the 2009 season.

A 5-day pest and disease survey of citrus orchards in the Punakha and Tsirang districts was undertaken in May 2009. The survey provided an invaluable insight into the occurrence and distribution of huanglongbing (HLB—citrus greening disease), together with the prevalence of the psyllid insects *Diaphorina citrii* and *D. communis* and their relationship with altitude. Additionally, it confirmed the importance of powdery mildew as a major cause of citrus tree dieback and death. A control strategy for this disease is urgently needed. It is suspected that a significant percentage of cases of orchard decline and tree death have been wrongly attributed to HLB, when the more likely cause has been powdery mildew infection.

Afghanistan

Position

ACIAR's program in Afghanistan aims to help the country recover from two decades of conflict by boosting wheat and maize production. Both are important staple food crops. Activities have focused on linking with multilateral research centres to introduce improved varieties that are better adapted to local conditions, and to multiply and disseminate seed of these varieties. Capacity building with local scientists through visits to research centres outside Afghanistan are also undertaken.

Achievements

The work to bring **sustainable wheat and maize production** to Afghanistan continued. Yield trials and screening nurseries were planned, designed, prepared and conducted in collaboration with the Afghanistan Research Institute of Agriculture (ARIA). The project is progressing steadily in four areas of collaborative work: to identify suitable varieties with high yield, good adaptation and superior disease resistance in Afghan farming systems; to develop/adapt appropriate wheat and maize production technologies; to build capacity; and to multiply base seed of experimental varieties resistant to the Ug99 strain of wheat rust.

Two new wheat varieties and three maize open pollinated varieties of International Maize and Wheat Improvement Center (CIMMYT) origin, released formally in 2008, were multiplied by seed-producing partners. Potential new varieties are in the pipeline. Five Ug99-resistant varieties were further yield tested and confirmed for resistance in Njoro, Kenya. Base seed of four Ug99 resistant varieties were multiplied in collaboration with ARIA.

CIMMYT staff involved in the project continued to contribute in the formulation of policies and procedures, and in the provision of advisory services on wheat and maize improvement to partners and NGOs. The role played by CIMMYT in the project was highlighted by a newly initiated partnership to further wheat and maize research and training with Kabul University's Faculty of Agriculture.

Progress was made in networking and strengthening partnerships. Efforts are underway to identify and prioritise production constraints, and to search for means to overcome technical problems in farm testing and verification.

Seed enterprise partners multiplied the 50-kg base seed of the two varieties handed to the Food and Agriculture Organization (FAO) in 2006. A total of 9 t of seed is now available for certified seed production.

Iraq

Position

Iraq's period of isolation from the international community during the first half of this decade, coupled with high levels of input subsidies, guaranteed commodity prices, and free food distribution, created significant disincentives to innovation. This was compounded by Iraqi scientists having limited access to international developments for more than two decades. ACIAR has one active project, co-funded by AusAID, that aims to modernise the agriculture sector through enhancing production of cereal crops in dryland areas. This is achieved through partnership with the International Center for Agriculture in the Dry Areas (ICARDA), an international agricultural research centre based in Syria, to trial modern crop varieties and introduce improved management options for those crops.

Achievements

A favourable review of a project to **improve production of wheat, barley, and pulse and forage legumes in northern Iraq** has led to further research to consolidate initial achievements and promote uptake of technologies with farmers and users.

Results of demonstrations of conservation farming were already reaching farmers and machinery manufacturers, and further encouraging outcomes are flowing in a follow-up project. The spread of the zero-tillage technique and other aspects of sustainable agriculture—from project activities to uptake in farmers' fields—is already significant. The basis of zero-tillage is minimal soil disturbance during the sowing of crops, and this in itself represents a radical departure from traditional ploughing.

In Iraq the 100-fold increase in diesel prices was an important driver of farmers' interest. Fortunately, this project and its predecessor were in the right place at the right time to take full advantage. It is now estimated that the area of zero-tillage practised by Iraqi farmers is approaching 500 ha, with zero-tillage demonstrations established with 20 Iraqi farmers in the first year of the new project.

The immediate benefits of reduced tillage include lowered costs; improved structure, fertility and water infiltration of the soil; and associated economic benefits on-farm. In the longer term, other countries have shown a reduction in dust pollution from reduced tillage, and also less smoke pollution as the burning of crop residues is reduced in association with zero-tillage practices. It is

expected that these longer term benefits to human health will similarly follow in Iraq as the improved technology gains momentum.

Changes in cropping systems towards zero-tillage practices require appropriate machinery modifications, and the project has been astute in providing small grants and a relatively free hand on machine specifications to local manufacturers—who have responded to the challenge with considerable energy and innovation.

A new project, focusing on the issue of salinity in central and southern Iraq, which are some of the world's oldest agricultural lands, began with an initial workshop at ICARDA in Syria in June 2009. The workshop, attended by representatives from Iraq, Australia, the International Water Management Institute and ICARDA, has developed a project framework to examine research options to manage salinity at the basin, irrigation district and farm levels.

Rebuilding agriculture in Afghanistan and Iraq

The wheat crop in **Afghanistan** falls short of demand by 1.5 million t/year. Looking for reasons, scientists from the Consultative Group for International Agricultural Research centres worked with the Afghan Ministry of Agriculture in the early 2000s. They found that farming infrastructure had collapsed and the country's agricultural biodiversity was in peril.

Given this ominous verdict, the investigators had highlighted the acute need for the country to regain food security. It was this imperative that led to the establishment of the joint ACIAR–AusAID initiative in support of CIMMYT efforts to improve Afghanistan's wheat and maize varieties. The project also focused on strengthening the nation's underlying farming capacity, agricultural infrastructure and scientific faculties.

With 85% of Afghan people involved in agriculture, rebuilding national capacity essentially revolves around rebuilding agriculture. The ACIAR-supported project work focuses on four areas derived from the country's recently formulated Agricultural Master Plan. Those areas are: screening international sources for resilient and high-yielding new varieties of wheat and maize; sourcing hundreds of tonnes of seeds for thousands of farmers; rebuilding agricultural infrastructure needed to test, bulk and distribute seed; and training Afghani scientists, technicians and extension workers to carry on the work.

Farmers are working with the research team to test the performance and acceptability of new varieties. One outstanding performer, Solh-02 variety, yielded 50% more than existing varieties and showed superior disease-resisting traits. It is scheduled for wider release.

The northern cropping region in **Iraq** provides 70% of the country's staple cereal production. Farmers there face many of the same problems arising in Australian farming—erratic rainfall, nutrient-depleted soils and the need for improved tillage practices.

Techniques that have been developed in Australia to address these problems, resulting in significant productivity gains, are being introduced to Iraq through ICARDA. New varieties of a number of staple crops—wheat, barley, and pulse and forage legumes—have been introduced, with higher-yielding varieties identified.

Farmers were invited to participate in these trials, and promising new varieties have been selected for scaling-up. Six wheat and five barley lines are now being grown. Improvements to cropping practices, focusing on the introduction of zero-tillage agriculture, are also being introduced in a newly commissioned project.

In September 2008 the Hon Stephen Smith MP, Minister for Foreign Affairs, announced Australia's commitment to strengthening Iraq's agricultural sector with a $4.7 million agricultural R&D project over 3 years to encourage farmers in northern Iraq to adopt conservation cropping methods in dryland agriculture.