

Australian Government

Australian Centre for International Agricultural Research

Annual Report 2007–08



ACIAR looks to the sun for energy savings

As part of ACIAR's environmental management system, solar roof panels have been installed at ACIAR House to reduce the building's energy use and operational costs and contribute to the Centre's commitment to renewable energy and sustainable energy use.



Letter of transmittal from the Chief Executive Officer

Australian Government Australian Centre for International Agricultural Research

The Hon Stephen Smith MP Minister for Foreign Affairs

Dear Minister

ACIAR Annual Report 2007–08

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 2008.

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 contribution made by ACIAR staff and commissioned research organisations to achieve more productive and sustainable agricultural systems for the benefit of developing countries and Australia through international agricultural research partnerships.

Yours sincerely

de come

Peter Core Chief Executive Officer ACIAR October 2008

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

The Hon Duncan Kerr SC MP Parliamentary Secretary for Pacific Island Affairs © Commonwealth of Australia 2008

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ACIAR Annual Report 2007–08

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Cover Photo: Sok Khim from Kandal Province in Cambodia helps sort the family's latest crop. Chilli has become a significant crop for many Cambodian famers who have diversified away from rice. *Photographer: Brad Collis*

Printing Statistics: 3,000 copies of this Annual Report have been printed and provided to key stakeholders.

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Four – year Snapshot

Financial (\$m)	2004–05	2005-06	2006–07	2007–08
Revenue				
Appropriation	47.523	49.334	50.362	51.242
AusAID funds	3.646	5.437	9.906	14.223
Other revenue	0.322	0.807	0.629	0.563
Total	51.492	55.578	60.898	66.028
Expenditure				
Bilateral research	29.507	32.805	36.206	39.211
Multilateral research	9.984	10.002	10.310	10.616
Education and training	2.565	2.909	4.132	6.375
Communicating research results	0.777	0.690	0.657	0.635
Total Research & Development Program	42.833	46.406	51.306	56.837
Salaries	4.784	5.177	5.327	5.375
Corporate Support *	3.820	3.836	4.210	3.788
Total Operational costs	8.604	9.013	9.537	9.163
Total	51.437	55.419	60.843	66.000

* Includes Executive, Commission, Policy Advisory Board

Operations	2004–05	2005-06	2006–07	2007–08
Collaborative Research				
Projects active in FY				
Bilateral	201	267	292	286
Multilateral	26	30	30	35
Projects started in FY				
Bilateral	51	76	97	75
Multilateral	7	6	8	8
Projects extended in FY				
Bilateral	41	47	106	103
Multilateral	4	2	10	11
Projects reviewed in FY ¹	24	34	35	14
Projects completed in FY ²	43	93	96	90
Building capacity				
Non-project specific training courses	13	13	12	11
Fellowships				
John Allwright Scholars active in FY	52	57	96	141
Scholarships awarded in FY	10	15	61	60
John Dillon Fellows in FY	6	5	7	10
Our Staff				
Staff – Public Service Act (FTE)	42.04	44.44	43.84	40.55
Overseas officers – Locally engaged (FTE)	20.5	20.5	20.5	20.5

¹ Includes both bilateral and multilateral projects

² Includes both bilateral and multilateral projects concluded and to be concluded as at 30 June 2008. Some of these projects may be extended following a review process

2007–08 at a glance

Revenue increased from \$60.9 million in 2006–07 to \$66.0 million in 2007–08. This larger revenue base featured an increase in funding of \$4.4 million to 21.9 million for an expansion of South-East Asia programs in Indonesia, Philippines and Laos, including projects co-funded by AusAID.

Key programs attracting budget support included:

- The collaborative ACIAR–AusAID program of agricultural research in Papua New Guinea
- The ACIAR components of the Smallholder Agribusiness Development Initiative in Indonesia (SADI) which increased by \$4.1 million to \$10.4 million
- Management of two of the four components of the Australia–Pakistan Agriculture Sector Linkages Program
- Continued support for the successful Seeds of Life program in East Timor.

Outlays lifted to \$66.0 million in 2007–08 from \$60.8 million in 2006–07. The **operating surplus** for 2007–08 was \$27,944, compared to \$55,000 in 2006–07.







Building capacity through training:

- During 2007–08 we expanded our **postgraduate training scheme** with a \$1 million increase in funding to \$4.6 million for postgraduate training—the John Allwright Fellowships supporting 40 new placements for partner country scientists within Australian Universities.
- Ninety-four per cent of our training course participants rated the ACIAR training courses as highly satisfactory or very good.

Adoption pathways closely addressed in the design of projects and private sector NGO partners are now actively involved in about 50 ACIAR projects.



Project partnerships 2007-08:

- ACIAR projects harnessed Australia's outstanding strengths in agricultural research to develop partnerships with developing country research institutions across more than 300 active projects.
- Continuing trend towards **larger**, **integrated programs** rather than numbers of small, free-standing projects
- More than 60 per cent of new projects in 2007–08 were designed to have significant farmer or policymaker impacts within five years of completion – exceeding the Annual Operational Plan target of designing 40 per cent of new projects to have a 'short time to impact'.
- ACIAR continued to support the rebuilding of scientific capacity and agriculture and aquaculture industries affected by the **December 2004 Tsunami** in Indonesia's Aceh province.
- Our programs in **Pakistan, Afghanistan and Iraq** continued to be challenged by circumstance but have delivered results in 2007–08 in post-conflict agricultural reconstruction through implementation of ongoing programs and a new project in Afghanistan to rebuild the wheat and maize industries.
- Projects tackle the **challenges Australia shares with the countries in our region** in a range of areas, including biosecurity, quarantine, climate change, and water management policy.

Some key research-related publications:

- Quality management of fresh produce from the highlands of Papua New Guinea: a postharvest manual
- Diagnostic manual for plant diseases in Vietnam
- Economic potential of land-use change and forestry for carbon sequestration and poverty reduction
- Achieving food security in China: implications of World Trade Organization accession
- Breeding and feeding pigs in Vietnam: assessment of capacity building and an update on impacts

36 publications produced in 2007–08 and more than 25,000 hard copies distributed



2007–08 at a glance

Our **impact assessment work** continues to show that ACIAR support for bilateral R&D activities is an exceptionally efficient means of investment in development assistance:

- Seven assessments were published in 2007–08, all showing continued strong investment returns to research.
- Large projects (more than \$400,000) completed in 2003–04 were reviewed in 2007–08, with results published in an Adoption Study Summary Report.
- Candidates selected for impact assessment with a program rather that project focus and with sampling rather than selection through expected successful impacts.
- The seven assessments published in 2007–08 show the **total net present value of welfare gains to partner countries and Australia was \$2.3 billion.**
- For individual assessments, the net present values ranged from \$6.1 million to \$1,105.5 million, with the corresponding benefit to cost ratios ranging from 5:1 to 257:1 and the internal rates of return from 25 per cent to 210 per cent.
- Assessments continue to show that ACIAR's collaborative partnership modality has a substantial impact on capacity building in our partner countries and the quantified welfare gains from this are substantial.
- Assessment at a program level revealed the complexities of R&D investment and the multi-faceted aspects of its impact. For example, over 20 years of fruit fly research has provided a significant return on the invested funds but the underlying story about how the impacts have been achieved and the circumstances under which they are not capitalised on provide important lessons for development of future activities.





Staffing levels (FTEs) at ACIAR did not increase in 2007–08. Outlays on salaries increased from \$5.3 million in 2006–07 to \$5.4

million in 2007–08.

LEFT: Fruits of long term work to rebuild agricultural capacity in Aceh

Impact Assessment Snapshot



Breeding and feeding pigs in Vietnam: assessment of capacity building and an update on impacts

The impact assessment (IA) found that the net present value of the benefits to all funding is \$1,988.3 million with \$1,105.5 million attributable to the original ACIAR and partner funding and the balance to the other funders of subsequent development activities. The rates of return to this ACIAR activity were estimated as a benefit to cost ratio of 257:1 and an internal rate of return of 74 per cent. The study also shows that \$422.7 million of the total \$1,988.3 million benefits are attributable to the capacity building activities developed in the ACIAR- and partner-funded activities.

The impact of increasing efficiency and productivity of ruminants in India by use of protected-nutrient technology

The dairy sector is an important part of agriculture in India. Productivity of dairy cows is recognised as being relatively low by international standards and feed quality and availability was identified as an important contributor. The adaptation of known protected nutrient technology from Australia to different feeds available in India was the focus of the ruminants research. The assessment estimates that the net present value of the welfare gains from the impact is \$232.1 million. The returns on the R&D investment are estimated as a benefit to cost ratio of 123:1 and an internal rate of return of 44 per cent.

ACIAR Fisheries projects in Indonesia: review and impact assessment

This study provides a review of all ACIAR-funded fisheries research in Indonesia and two detailed impact assessment studies – tuna capture fisheries and shrimp aquaculture. For captured fisheries management, the assessment shows that the capacity developed in early projects contributed significantly to Indonesia becoming a member of a regional fisheries management group and to the associated access to high value markets for southern blue fin tuna caught in Indonesian waters. The estimated net present value of the welfare gains from the investments required to achieve Indonesian membership of this regional group is \$1,100 million. The share of these returns attributable to the ACIAR supported component is assessed to be \$168 million, indicating a return on ACIAR- and partner-invested funds of a benefit to cost ratio of 179:1 and an internal rate of return of 210 per cent.

For shrimp aquaculture the research developed effective technologies for pond remediation. The net present value of the welfare gains from the impact is estimated to be \$547 million with a benefit to cost ratio of 52:1 and internal rate of return of 26 per cent.

A review and impact assessment of ACIAR's fruit fly research partnerships - 1984-2007

Fruit flies are a major pest in Australia and most of ACIAR's partner countries. ACIAR has invested in several areas of fruit fly research for over 20 years. The review and impact assessment of this major research program found a complex story with a diversity of potential impacts and strong demands on institutional and policy systems to be able to capitalise on research results. The return from the substantial investment by ACIAR and its partner countries is significant with a net present value of \$208.1 million, a benefit to cost ratio of 5:1 and an internal rate of return of 33 per cent. However, these benefits are distributed in a complex manner between the 15 partner countries and Australia.

Commission Chair's and Chief Executive **Officer's Review**





The year in review

The linked challenges of world food security and global climate change, together with a renewed emphasis on the importance of international agricultural research and development (R&D), have marked this last year. The global food crisis has been described as a 'silent tsunami' – but a man-made rather than natural catastrophe. We are seeing the outcome of a nexus between high prices for energy and food, exacerbated by global climate change. This unfortunate combination has led to rising costs of production and transport for agriculture, rising food prices and falling food stocks, while land is increasingly shifted out of food production to produce energy substitutes.

The food crisis is now on the G8 agenda, highlighting a heightened awareness and global concern that developing nations are suffering under the dual weight of record fuel and food prices and a recognition that the food crisis has become a sensitive political and security issue.

The unprecedented challenge to agriculture has put international agricultural R&D on centre stage. The Crawford Report (1976), which led to the formation of ACIAR, recognised that agricultural research and development has a critical role to play in the development process, stating that 'research assistance is one of the most effective ways of helping developing countries to achieve, by their own efforts, economic and social progress'. Now, in the midst of the current food security crisis over 30 years later, the World Bank concludes in their World Development Report 2008 that 'improving the productivity,

profitability, and sustainability of smallholder farming is the main pathway out of poverty in using agriculture for development', with innovation through science and technology being one of the key instruments.

It is clear from the current crisis that the world is changing in ways that affect developing countries most and the livelihoods of threeguarters of the world's poor will continue to depend on agriculture. Over the past ten years the developed world has stood by while productivity gains of basic staples - rice, wheat, maize and cassava - have stagnated. Productivity gains of these key crops must double to more than two per cent per annum, and this must be achieved in an era of climate change.

Growth rates of yields for major cereals are slowing in developing countries



Source: World Development Report, 2008

We have been too complacent about our ability to feed the world. Agricultural supply must be boosted and this will need increased research spending – reversing years of agricultural underinvestment. Moreover, we

are nearing the half-way point towards the 2015 target for achieving the Millennium Development Goals (MDG), and we find the work to date and our achievements are clearly under threat. ACIAR has a special role to tackle these new challenges to agriculture and redouble our efforts.

The International Food Policy Research Institute and others have noted the causes of the food and agriculture crisis are complex and require a comprehensive response which needs to be both context- and region-specific. The Institute has identified the convergence of issues from supply and demand sides that produced the current world food crisis. Chief from the supply side are the lack of investment in agriculture and agricultural R&D, energy prices, poorly developed infrastructure and misconceived government policy actions. Increasing population, rising incomes and use of food for biofuels dominate the demand-side issues.

World Commodity Prices, January 2000–February 2008 (US\$/metric ton)



Source: FAO international commodity prices database 2008, and IMF world economic outlook database 2007.

In the short run, humanitarian aid, socialprotection programs and trade policies will determine how well the world copes with these problems. In May, the World Bank unveiled a \$1.2 billion fast-track funding facility to help combat the impact of rising food prices on the poor. The Food Price Crisis Response Core Multi-Donor Trust Fund was established to help vulnerable countries cope better, over the medium term, with higher and more volatile food prices. Since May Australia has committed an additional \$80 million in funding to assist with the current crisis. This comprises a contribution of \$30 million to the World Food Programme in response to its emergency food aid appeal and \$50 million to the World Bank to help stimulate agricultural supply. Australia has also committed to increasing its aid budget to 0.5 per cent of Gross National Income (GNI) by 2015.

In the medium term the pressing issue is to resolve where and how the world produces more food. A global response must address the decline in agricultural productivity growth and at the same time address the transformational opportunities emerging from this crisis, such as higher prices, to help smallholder farmers and build resilience to future food crises. Unlike emergency relief, in the aftermath of disaster, agricultural aid aims to establish a deeper and more enduring food security capability.

Many are calling for a second 'green revolution', modelled on that which staved off famine in Asia in the 1960s, 70s and 80s through new high-yielding rice and wheat varieties, and boosted rice production to give the region a surplus for several decades. Others argue the second 'green revolution' will be harder to achieve than the first because of acute land and water restraints and climate change.

We recognize the critical need to focus on the productivity growth of the staples of the food security systems – the major cereals. The shift in food demand towards animal proteins will inevitably put pressure on the basic staples because they are also used as animal feed. Moreover, if food provision is going to increase, we also need 'more crop per drop (of water)' because of the fresh water challenge in the changing climate. Our research partnerships will therefore need to focus on building stress-tolerant crop cultivars of the basic staples, also on conducting site-specific trials of these cultivars in the key production areas,



Per capita food consumption in developing countries is shifting to fruits and vegetables, meat and oils

Source: World Development Report, 2008

enhancing water productivity, and slowing the rate of deforestation.

Meeting the year's challenges

In its programs, ACIAR has responded to the challenges and built on its experience, creating research and extension partnerships that have successfully improved and secured food production in developing countries, particularly in our own Asia-Pacific region. The agency has also drawn on its global presence and perspective and its long-standing partnerships with the International Agricultural Research Centres (IARCs) that form the Consultative Group on International Agricultural Research (CGIAR). By working with the centres, we not only draw on expertise, we also support maintenance of crucial genetic resources and help preserve the genetic diversity which is fundamental to food security.

By drawing on this genetic diversity to improve crop varieties in developing countries that have experienced civil unrest or war, Australian aid, and ACIAR in particular, has helped communities along the road to economic recovery. Examples of our current work that highlight the importance of preserving genetic diversity include the Seeds of Life Program in East Timor, a new wheat program in Afghanistan, and another addressing crop productivity problems in Iraq. Developing countries are more likely to suffer through climate change because they rely on agriculture for employment and contribution to their economies. Thus poor smallholder farmers expect to bear the brunt of climate change impacts first, and ACIAR funds several projects to assist them – addressing seasonal forecasts, climate change mitigation and adaptation. Most of our work has focused on building the capacity of farmers to respond to climatic changes, again through the development of more sustainable, resilient agricultural systems. Changed farming practices and new crop varieties play a vital role in delivering better water use efficiency, tolerance to drought and water logging, and resistance to the pests and diseases predicted to proliferate in a changing climate.

The ACIAR project modality and partnership model have led to successes in the past and will continue to do so. More than ever, Australia and ACIAR are well placed to contribute to the current challenges, based on the proven formula of partnerships between Australian research institutions and national research systems in developing countries, often with IARC involvement. Because we share the tropical and semi-arid agro-climatic conditions and associated challenges with many of our partner developing countries, our expertise is in demand. And the results speak for themselves: ACIAR Impact Assessment Studies and Meta-analysis of ACIAR Bilateral Investments clearly demonstrate that partner countries and Australia gain direct economic benefits well in excess of annual outlays from agricultural, forestry, fisheries and policy research.

Performance and programming for success

As revealed in the body of this Report, 2007–08 was a year of solid performance against targets set in the 2007–08 Annual Operational Plan (AOP) and the Portfolio Budget Statement. We have continued to deliver good results in an operating environment where funding to international agricultural R&D has stagnated, the cost of doing research has increased and Australian research providers are increasingly requiring ACIAR to shoulder a greater proportion of the project costs.

The Annual Report outlines the scope and position for our work in each country in which we operate, and provides details of the progress and headline achievements of our programs and individual projects. With much of the most important agricultural innovation requiring significant and longterm (5-10 year) investments to translate the research investment into productivity outcomes and reduced poverty, planning continued to play a key role at ACIAR in 2007-08. Our AOP provides the details of country-specific and regional issues, along with current and foreshadowed priority initiatives for cooperation with individual countries and international centres. The 2008–2012 Corporate Plan is intended as a broader road map. These documents have emerged from a complex consultative process with clients, partners and stakeholders and aim to provide them with a clear sense of our directions and key objectives.

Beyond our core mandate of supporting agricultural innovation to achieve development outcomes we have also contributed to the whole of government response to specific development challenges and worked on a range of wider Government initiatives. In 2007–08 we received additional funding through AusAID to support specific joint programs. We participated in the Australia-Indonesia Partnership (AIP) to support Indonesia's reconstruction and development efforts, both in and beyond tsunami-affected areas. Another such initiative was the Australia-Pakistan Agriculture Sector Linkages Program (ASLP) between the agricultural sectors of Australia and Pakistan. Other co-invested project work has been in the Philippines and Iraq. The trend towards making program co-investments with AusAID continued while in other areas our research investments have complemented AusAID's development programs.

Our new Corporate Plan notes that, more than ever, our programs need sharper focus, more integration with overall development efforts, and concurrent flexibility to respond to the immediate needs of partner countries. An essential characteristic of our program work in 2007–08 has been a strong alignment with whole of government Australian aid program strategies for the individual partner countries and an evolution in program and project design. We are now developing fewer 'stand alone' projects; instead we develop either clusters of closely-linked projects addressing a common program theme or larger multidisciplinary projects addressing critical issues. In 2007-08 a number of larger integrated projects under development involved individual investments from ACIAR and included: the southern Philippines horticulture initiative; application of molecular markers in wheat breeding in India; and profitable and sustainable farming on poor sandy soils of south central coastal Vietnam.

ACIAR has a long history of significant investment in quantitative assessment of the impact of our research funding. In 2007–08 we developed a new set of guidelines for undertaking impact assessment studies for ACIAR projects and added Project Impact Assessment Summaries to our suite of work. This year we also instituted a process to link our impact assessment work to the activities of the Office of Development Effectiveness (ODE).

Building an effective organisation

During 2006–07 the Australian Government assessed the governance arrangements of ACIAR against the principles and recommendations of the Uhrig Review. This review, undertaken by Mr John Uhrig, AC, sought ways to achieve the most effective accountability and governance structures across the whole of government, for ACIAR and other statutory authorities in the Foreign Affairs and Trade portfolio. As a result ACIAR's Board of Management transitioned to an executive structure comprising a Chief Executive Officer (CEO) and a seven-member Commission. This process was formalised in June 2007 with the Australian Centre for International Agricultural Research Amendment Act 2007 receiving Royal Assent and the amending legislation providing for a number of changes to the governance arrangements of ACIAR with effect from 1 July 2007.

A key focus of 2007–08 was on accommodating and implementing the new governance structure to ensure that ACIAR met the expectations of the Minister and the Portfolio Secretary under the new arrangements and also supported the new ACIAR Commission in carrying out its responsibilities. The transition and implementation process was relatively seamless and has led to an efficient and effective executive management structure and well integrated corporate governance framework. ACIAR's staff members have embraced the new arrangements with enthusiasm and commitment.

The new ACIAR Commission advises the Minister on the strategic directions of ACIAR while the CEO provides operational leadership. The CEO is a member of the Commission and has Head of Agency powers as set out in Part 7 of the *Financial Management and Accountability Act 1997* and Part 9 of the *Public Service Act 1999* respectively. The CEO is now directly responsible to the Minister for managing the affairs of ACIAR in a way that ensures proper use of the Commonwealth resources. The functions of the Commission focus on provision of advice to the Minister in relation to the formulation of agricultural research and development programs, the funding of these programs and, on the Minister's request, any other matter relating to the ACIAR Act. The ACIAR Policy Advisory Council continues to facilitate the building of strategic partnerships and its membership is drawn largely from our partner countries.

During the last year Australia also had a change of government and consequently the agency has been involved in the Government's revised agenda for the aid program. This included the AusAID-led whole of government response to the global food security crisis. The new Government's commitment to increase Australia's Official Development Assistance (ODA) mentioned earlier will lead to a scale-up of expenditure in major sectors influencing Millennium Development Goal outcomes and a stronger focus on rural development assistance to lift agricultural productivity in key staple crops. Most importantly for ACIAR, Australia's world-class scientific expertise will have greater involvement in research to further boost agricultural productivity.

The year ahead

The agency moves into 2008–09 with a challenging agenda and a spotlight on international agricultural R&D. We recognise the urgency for increasing agricultural productivity, particularly for local staple crops, and fostering cash income-generating opportunities for those whose livelihoods depend on agriculture. And we must rise to these challenges within a framework of better natural resource management and greater climate variability.

Finally, our thanks go to the Commission members, the Policy Advisory Council and the ACIAR team – the staff and research partners here and overseas – for their professionalism, commendable contributions and dedication to ACIAR and its mission.

Dr Meryl Williams	Mr Peter Core
Commission Chair	CEO

Research Program Management

(as at 30 June 2008)



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Papua New Guinea and the Pacific

Financial year	Regional expenditure	Percentage of total project expenditure	Commission target as percentage of expenditure
2007–08	8,161,038	19.0%	>20%
2006–07	8,194,666	20.8%	>20%
2005–06	7,467,164	21.2%	>20%

ACIAR's programs cover five regions. Papua New Guinea and the Pacific islands are grouped as one region. Outlays for the region have been rising in recent years to meet the priorities placed on the region by the Australian aid program. For the region an expenditure target of more than 20 per cent of our overall research expenditure has been set.

PNG	19
Pacific island countries	28



Papua New Guinea

AOP budgeted expenditure in 2007–08	\$4,826,552	ACIAF
Actual expenditure in 2007–08	\$4,964,469	'right,
Expenditure in 2006-07	\$5,050,940	dui W
Expenditure in 2005-06	\$4,896,886	Dr Jac



Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
Constraints to expansion of inland aquaculture identified and strategic planning for development commenced	With counterparts, ACIAR initiated national aquaculture priority-setting/coordination meetings. Major constraints to inland aquaculture identified as supply of fingerlings and feed, and training and extension. Inland pond aquaculture project redesigned to better address constraints.
Increased capacity for regional fingerling and feed supply to underpin aquaculture expansion	Improvements in fingerling supply from Eastern Highlands Province hatchery limited but an increase in supply from regional hatcheries (run by private farmers and NGOs) achieved. Research led to major improvements in survival of fingerlings during transport. Four mini-feed mills established at regional centres, and two are already functioning well.
Greater involvement of PNG University of Technology in ACIAR's program	Five Postgraduate Diploma students identified for study at PNG University of Technology in 2008. The students work across ACIAR projects including crop production, evaluation of broiler diets, peanut diseases, farm fish diets and forestry seed production. Since 2005, 19 postgraduates have successfully graduated from this program.
Enhanced focus in project portfolio on improving the quality of commodities	Nine ongoing projects focus on improving the quality of commodities such as timber, sweet potato, coffee, peanut and cocoa.
Maintain linkages between at least two ACIAR projects and projects funded under the new AusAID Agricultural Innovations Grants Scheme	There are strong linkages between at least five ACIAR projects and the projects short-listed under the AusAID Agriculture Innovation Grants Scheme. However, final selection of AIGS projects was pending in June 2008.
Greater involvement of PNG University of Technology in ACIAR's program	PNG University of Technology actively involved in five ACIAR projects in 2007–08, an increase from three projects in 2006–07: cocoa integrated pest and disease management; livestock diseases; and agroforestry value addition.

Key performance indicators	Performance 2007–08
Increased partnerships with other agencies promoting sustainable economic development, in particular the Ok Tedi Development Foundation and the PNG Sustainable Development Program	Ok Tedi Development Foundation current partner in a project on indigenous fish culture and a new partner in the village broiler production project. The PNG Sustainable Development Program is collaborating in implementation of the PNG agroforestry systems project. Several NGO partners are formally involved in ACIAR's program, including World Vision, Lutheran Development Services, Salvation Army Development Program, Rural Women's Development Initiative, People's Action for Community Development, AT projects, HOPE Worldwide and PNG Ecoforestry forum.
Increased emphasis in ACIAR portfolio on sweet potato research and development, commensurate with its importance as a staple food	A cluster of projects addressing production, postharvest quality and marketing of sweet potato have been initiated. These include projects on marketing efficiency, postharvest management and value addition, pest and disease impact on yield, high-carotenoid sweet potatoes, farmer evaluation and multiplication and soil fertility management, with regular communication among project collaborators and joint training activities.
Extent of soil fertility decline of PNG highlands quantified and suitable research and development investments to improve soil fertility implemented	The extent of soil fertility decline and major constraints to production of the most important staple, sweet potato, were identified. The main objective of SMCN/2004/067 is to investigate improved nutrient and water management options for sustainable sweet potato based cropping systems.
Increased emphasis on promoting the role of indigenous nuts in local and export economies	One project addresses processing, handling and storage issues for galip nuts and another addresses regional marketing of the product.
Stronger emphasis on enhancing the contribution of forestry to the national economy, in particular by linking commercial forestry to traditional agroforestry and community management of forests, and by strengthening domestic processing	A project seeks to integrate highly commercial species such as teak and PNG walnut into traditional agroforestry systems, and is making good progress. A second project is addressing the development of a more sophisticated domestic timber processing industry.
At least 40 per cent of new projects designed to have significant farmer or policy-maker impacts within five years of completion	Of 10 new projects that started in 2007–08, six designed to have significant impact on farmers or policymakers within five years of completion.

Position

In 2007–08 the ACIAR–Papua New Guinea (PNG) program continued to support applied technical and economic research aimed at the enhancement of incomes for smallholders. The clustering of research projects around particular issues was further strengthened to improve project integration around priority needs. For example, the project cluster on root crops covered a range of issues from identification of sustainable and profitable production systems to postharvest handling and marketing. Forestry activities focused on linking commercial forestry to traditional agroforestry and strengthening domestic processing to produce high value products. Interlinked projects in fisheries and aquaculture analysed the major constraints to increasing production and various approaches to better address the constraints.

A key component of Australia's support to the agriculture sector in PNG has been AusAID's partnership with ACIAR. This partnership was reviewed in February 2008 and a new partnership covering a period of five years from mid-2008 was negotiated to secure a more strategic and reciprocal affiliation between the two agencies.

A series of consultation meetings in different sectors (horticulture and food crops, forestry and fisheries) was held in PNG in May 2008 involving PNG participants from government, the private sector, NGOs and the community. Of particular interest was the emphasis across all commodity sectors on cultural, social, and economic constraints to adoption of new, and even existing, technologies.

Achievements

Subprogram 1: Enhancement of smallholder incomes from agriculture

A. Social and economic constraints and opportunities

New work commenced to raise smallholder productivity and incomes in the oil palm and cocoa sectors through identifying, refining and promoting effective strategies for commercial sector partnerships with



Prime Minister Mr Kevin Rudd meets with ACIAR Country Office and High Commission staff on his visit to PNG in March 2008

smallholders. Examples of commercial sector engagement are the provision of farm management advice/sale of inputs to smallholders, and joint venture companies between the commercial sector and customary landowner groups that entail various tenancytype arrangements with conditions of land use. The objectives are 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 is to implement innovative payment systems for productivity-enhancing inputs that accommodate the socio-cultural context of smallholder production.

A Tasmanian pesticide manufacturer has come to the aid of women in the PNG highlands, offering to support the region's faltering pyrethrum industry. Botanical Resources Australia approached ACIAR and the Centre agreed to support a project to improve seed lines and seed production through better growing and harvesting. The farmers, mostly women and youth groups, are helped through informal training at their farm sites where they cover topics such as better ways of planting the crop, better management practices and the right time to pick. The skills and technology that the company is introducing have wider applications for other crops such as fresh market vegetables.



Seedling distribution to pyrethrum growing families in PNG



Farmer involvement in sweet potato variety trials

B. Root Crops

The farmer evaluation and multiplication of sweet potato project ended in November 2007. During the three-year project, with the assistance of National Agricultural Research Institute (NARI), the project selected 16 different varieties for trial at approximately 142 technician-controlled sites during both wet and dry seasons. After discarding two varieties, the remaining 14 varieties (which included two farmer controls) were tested in approximately 350 farmer-controlled trials, again during both the wet and dry seasons. Data were collected from over 120 trials. The farmers' evaluation of these varieties has been recorded and collated. generating a list of farmer criteria for the adoption of new varieties. In addition, the project also conducted four sequential trials to determine optimum harvesting time for all 16 varieties. Sharing of all findings will take place through a workshop and final technical report. Planting material has now been provided to the wider community, involving 800 farmers, and an estimated 1,400 have subsequently received material from these farmers.

Work has been also undertaken in PNG highlands to identify promising agronomic practices to increase **the productivity of sweet potatoes**, while sustaining soil fertility. The PNG highlands is among the world's



PNG post graduates pass with flying colours at Unitech in Lae, PNG

fastest population growth areas with much intensification of land use. This is placing unprecedented pressure on the land resource and on the long-term productivity of sweet potatoes, the main staple. The project has established an effective network with local institutions and NGOs and on-farm field trails are being conducted in close collaboration with the farmers. The primary target group are smallholder producers in the more accessible and densely populated parts of the highlands that are producing at least some of their crop for small scale commercial marketing, and that therefore have some capacity to invest limited resources into intensifying their production systems. Underpinning this dual strategy is a strong focus on capacity building in soil research and management so that further research and dissemination of soil management techniques can be carried out beyond the life of the project. The inception workshop for new work improving the marketing efficiency, postharvest management and value addition of sweet potato was held in Goroka. Good planning progress was made and partners are enthusiastic regarding the project's potential. A key aspect is the involvement of women's groups from Mt Hagen.

C. Tree Crops

Palm oil is PNG's most important export product, having surpassed coffee several

years ago and having since maintained that position. The main production areas are in West New Britain Province, followed by Oro Province. In both provinces magnesium deficiency is widespread, affecting the oil palm production severely. In many locations direct application of magnesium fertilizers did not show any effect, indicating the need for better understanding of underlying problems related to magnesium deficiency. A project is conducting a series of field investigations and laboratory studies to find a technically efficient and economically viable solution to it. The project is also examining the interactions of magnesium with other plant nutrients such as potassium and nitrogen and a valuable database has been prepared to facilitate the issuing of site-specific fertilizer recommendations to both small holders and estate managers.

Sago is the staple diet in selected areas of PNG (particularly Western Province and East Sepik). But a project has revealed that sago is subject to serious contamination. During the course of the project at least one episode of sago haemolytic disease (SHD), thought to be due to fungi or mycotoxins in the starch, occurred in Western Province. Project members tested a sago sample from the home of the affected family and documented local medical treatments and patient responses. This provided a valuable opportunity to confirm the possible cause of SHD. The project later identified a potential novel compound from a fungal isolate derived from sago starch that shows strong haemolytic activity with human red blood cells. The project also found that fermentation and storage of sago in palm leaf bundles (in Western province) and clay pots (in East Sepik) posed a relatively low contaminant risk when consumed within a few weeks. By contrast storage in baskets resulted in inferior fermentation and greater risk of contamination from soil or faeces and subsequent chance of food poisoning or SHD.

Subprogram 2: Sustainable management of forestry and fisheries resources

The **purse seine fishery** in PNG is strongly dependent on floating objects as attractants, in particular anchored fish aggregation devices (FADs). Juvenile yellowfin and bigeye tuna tend to aggregate in large quantities around

FADs, and therefore constitute a significant proportion of the catch. Recent regional stock assessments have raised concerns about the long-term viability of these stocks. ACIAR is supporting a Secretariat of the Pacific Community (SPC) regional project which is obtaining information on the dynamics of bigeye, yellowfin and skipjack stocks in PNG waters. The primary method used by the project is to tag-and-release the target tuna species (yellowfin, skipjack and bigeye) in PNG waters. Four periods of vessel charter, involving a commercial pole-and-line vessel, took place. This resulted in 102,400 tunas being tagged and released over a wide area of the PNG Exclusive Economic Zone (EEZ) and neighbouring sections of the Solomon Islands EEZ. As of April 2008 more than 10,000 tags, mostly with good information, had been returned to SPC, representing an overall recovery rate of 10 per cent, in line with expectations of a final return rate of 20 per cent.



Smallholder incomes are enhanced through improved agricultural practices

Locally available animal protein sources for highland communities and subsistence farmers in PNG are limited. ACIAR has initiated a suite of linked projects aimed at the promotion of inland aquaculture based around simple low input pond culture of tilapia and carps to supplement family food budgets and, where circumstances permit, to provide new livelihood opportunities for interested farmers. One project aims to improve fingerling supply and fish nutrition for inland aquaculture on smallholder farms, to address what were identified as the major constraints to the sustainability of current farms. Farm-based feeds and husbandry for smallholder fish farmers are also being examined. This is a project with a national focus and, in the last 12 months, smallholder farmers, NGOs and government officers from a range of Lowland Provinces have received training and extended their skills at two project workshops held at the Erap Aquaculture Centre.

Another potential solution is the culture of **suitable freshwater native fish and crustaceans**. Partners Ok Tedi Mining Limited and Western Province have contributed to a project by establishing some ponds for holding broodstock, identifying model farmers, and conducting training. Some native species classified as good potential for aquaculture and restocking have now been supplied to stock the ponds. These include eeltail catfish, sleepy cod, sooty grunter and redclaw crayfish.

Subprogram 3: Biosecurity policy and capacity enhancement

ACIAR has funded six years of project involvement in the **management of taro beetle** pests in PNG and Fiji. Commissioned organisation SPC also used funds from the European Union's project 'Plant Protection in the Pacific' to extend activities to Kiribati, New Caledonia, Solomon Islands and Vanuatu. Research conducted with a fungus, *Metarhizium anisopliae*, led to high beetle mortalities, but damage to the taro corms occurred before the beetles were killed. It was much more effective



Improving fingerling supply and fish nutrition for smallholder farms involved in inland aquaculture in PNG

to judiciously apply suitable insecticides. Using the results of the first four years of work, recommendations on dosages, frequency, methods of application and safety of selected insecticides, imidacloprid and bifenthrin, and other taro growing practices, were demonstrated at Farmer Field Schools in PNG, Fiji, Vanuatu and Solomon Islands. The synergy on low dosages of imidacloprid with *Metarhizium* was also demonstrated. A taro beetle management package resulted. Project results are restoring confidence in taro growing communities of the Pacific and PNG.

A project to learn more about the red banded mango caterpillar, a serious pest of mangoes in parts of Asia and now infesting PNG, Torres Strait and the northern tip of Cape York, has gathered information about the biology of the pest, assessed damage levels on fruit and looked for ways to control it. HortResearch NZ had identified a pheromone (which attracted moths into a trap) and this was extensively tested in PNG. After success in PNG the research team set pheromone traps and undertook surveillance to monitor levels of infestation in all five communities of the northern area of Cape York Peninsula. Follow-up testing of the pheromone by the project team and others indicates that pheromone lures have potential as part of an early warning system for detecting the presence of the caterpillar in orchards.

Improving human vitamin A status in Papua New Guinea and Solomon Islands

Many people in Papua New Guinea and Solomon Islands do not receive enough dietary vitamin A, which is vital in boosting immunity to disease. Particularly at risk are infants, children and pregnant/nursing women. Vitamin A supplementation of infants in PNG reduced the effects of malaria, but it would be preferable to receive enough vitamin A through the diet.

Another concern is the large increase in the so-called metabolic or lifestyle diseases such as diabetes, obesity, cardiovascular disease and certain cancers during the past 50 years throughout the Pacific and PNG. This is largely the result of the substituting refined, nutritionally poor products such as white flour, white rice and sugar for traditional highly nutritional diets based on local foods, combined with lack of proper exercise.

The orange sweet potato (OSP) 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. An ACIAR-funded project is helping to alleviate the problem of too little vitamin A by assessing coloured Solomon Island and PNG sweet potato cultivars for carotenoids.The project also seeks to understand the cultural and social dimensions of sweet potato in the diets in Solomon Islands and PNG in an effort to promote OSP as a healthy dietary component and to increase its consumption. Linked to this, the team is introducing improved OSP cultivars (sourced from the International Potato Center) for comparison with the highest-carotenoid local cultivars.

Collection of sweet potatoes is taking place in many parts of Solomon Islands – from Santa Cruz Islands, Makira, Santa Ana, Guadalcanal and Western Solomons/ Isabel; World Vision has also sent samples from Madang, PNG. So far, project members have collected and analysed over 50 orange/yellow sweet potato varieties, together with a selection of sweet potato leaf samples and other food crops. They also found that cooking tubers and leaves in coconut cream enhances carotenoid bioavailability.

The project is educating the villagers on the value of including these high nutrition foods in their diets – using workshops, talks and distribution of promotional material. Materials are now being developed in collaboration with World Vision and NARI as part of an effort to bring similar benefits to other areas of Solomon Islands and to Madang Province, where the population has been identified as having the highest risk of vitamin A deficiency in PNG.

The fungus disease **potato late blight** has affected the previously flourishing crops of the PNG highlands. The disease can be combated by an intensive control regime that includes fungicides sprayed every 3–5 days. The best means of dealing with the problem is to identify and distribute blightresistant varieties, and an ACIAR-supported project involving the International Potato Centre (CIP) is working to develop affordable varieties, backed up with low-impact reliable fungicides to deal with emergencies. An extension program is also helping to rebuild local confidence in potato cultivation. Approximately 50 different potato clones are being evaluated and tissue culture



Collecting seed in the forests of PNG

methods employed to multiply the material for further testing and to fast-track vegetative multiplication so the resistant varieties can be distributed quickly.

Increasing the productivity of livestock depends largely on addressing a range of constraints, including those caused by diseases such as leptospirosis and trichinellosis, two zoonotic diseases (capable of transmission from animal to human). In PNG excellent capacity-building has taken place among technical and professional staff, and there has been strong engagement with commercial cattle producers. Encouraging progress includes development of antibody detection tests for Trichinella and Leptospira and establishment of serological diagnostic capability for these organisms at the National Veterinary Laboratory. There is now improved epidemiological knowledge about leptospirosis infection in cattle in PNG, and confirmation *T. papuae* is more widely distributed in PNG than previously thought. The project has made use of an extensive SPC serum bank and has generated much valuable baseline information for further activities.



Agronomic practices increase the productivity of sweet potatoes

Pacific island countries

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AOP budgeted expenditure in 2007–08	\$2,781,416	ACIAI r, PNG Inds
Actual expenditure in 2007–08	\$3,196,569	ʻright, inage on Isla
Expenditure in 2006–07	\$3,143,726	cqui M try Mc olome
Expenditure in 2005–06	\$2,570,278	Dr Ja Coun and S

Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
Fisheries management arrangements enhanced or economic analyses completed in at least two countries	The establishment of effective community-based management plans for sea cucumber resources in Solomon Islands has been the focus of a three- year effort in collaboration with the WorldFish Center. Success has proved elusive, and a major new activity is planned to assist communities to better manage their inshore reef-based resources.
Demonstrated integration of existing farming systems knowledge and/or adoption of earlier research in at least four Pacific island projects	Integration of existing farming systems knowledge/ adoption of earlier research is demonstrated in several Pacific horticulture projects. For example, one program is utilising root crop germplasm from previous ACIAR PNG and Pacific projects; another is using earlier plant defence stimulator research from a previous project in China; another builds on integrated pest management tools developed in China and DPR Korea; and two others incorporate outputs from sweet potato research in PNG.
Demonstrated development and successful field testing of integrated crop management practices for at least two horticultural crops	Development and successful field testing of integrated crop management practices for Kabocha squash in Tonga (including an Integrated Pest Management strategy) and in brassicas (broccoli and cabbage) in Fiji, with a particular focus on integrated pest management strategies using either alternatives to synthetic pesticides or more targeted use of lower amounts of safer pesticides.
Improved agricultural statistics or marketing systems indentified, developed and tested in at least two Pacific island countries	In a project measuring and forecasting systems for smallholder production and consumption and sales and market-based models for policy simul- ations have been developed and are being used in the project. In another, a computable general equilibrium model supplemented by partial equilibrium studies has been used to assess the economic and environmental impacts on the Fijian economy of agricultural trade liberalisation, increased agricultural production and trade, providing valuable information for the formulation of policy advice.

Key performance indicators	Performance 2007-08
Field testing of promising sustainable management practices and value addition demonstrated in forestry and agroforestry projects	Projects aimed at testing and implementing sustainable agroforestry systems with high value species are under way with whitewood in Vanuatu, and another with teak and rosewood in Solomon Islands. Another project aimed at developing coconut wood for the Australian flooring market is making good progress.
At least 40 per cent of new projects designed to have significant farmer or policy-maker impacts within five years of completion	Four of the five new projects commenced in the Pacific in 2007–08 were designed to have significant farmer or policy-maker impacts within five years of completion.

Position

ACIAR's position in the Pacific islands will continue to develop in line with broader Australian development assistance priorities. There is an increasing awareness of the importance of changing economic and environmental situations and the vulnerability of small developing island states if flexibility and adaptation to change is not achieved. While each of the Pacific island countries has specific agricultural industry constraints and issues, these countries have a range of common challenges including eroding tariff preferences, population and urban growth, migration of skilled labour, resource depletion and degradation and risks from global warming.

Participation in regional projects that address common problems has assisted with helping to overcome the limited capacity of many countries to engage in collaborative activities. ACIAR's 2007–08 program has had a strong emphasis on working with Pacific Regional



Organisations to improve effective delivery of outputs.

In 2007–08 the ACIAR program has taken a holistic approach, linking agriculture, forestry, fisheries and environment more closely. ACIAR has had the opportunity through a number of projects to explore new niche agricultural, fisheries and forestry products to achieve diversification and income growth as well as facilitating domestic and export market access through a focus on biosecurity issues and improved quarantine resources.

Achievements

Subprogram 1: Improving incomes through productive farming systems

Sustainable aquaculture development is imperative in the Pacific islands region. A series of 14 miniprojects has focused on eight aquaculture commodities in nine Pacific island countries. Examples of outcomes include determination of the viral disease status of Penaeus monodon shrimp stocks in Fiji, paving the way for the development of improved guarantine and testing procedures, and demonstration that the native freshwater prawn Macrobrachium lar can be successfully cultured in ponds as an alternative to the introduced M. rosenbergii. Other projects demonstrated improvements in husbandry for artisanal fish farmers in PNG and Fiji through formulation of cheap, locally available fish feeds. In Solomon Islands the research team developed improved sponge culture methods and investigated markets for Pacific bath sponges. Building on this work, an EU-funded project is supporting village-based farming operations with the aim of producing sufficient



ACIAR funds a range of fisheries management projects in the Pacific

quantities of sponges to allow a realistic assessment of the market potential in New Zealand to be evaluated. Through mini projects, local farmers and aquaculture officers in a number of countries have now been trained to collect and/or breed and culture species such as Nile tilapia, indigenous freshwater prawns, anguillid eels and sponges. Fisheries officers also increased their skills in a wide range of areas including feed formulation, feed management, mabe (half pearls) pearl production, survey techniques, water quality monitoring and data recording.

Another aspect of the WorldFish program involved capture and culture of presettlement coral reef fishes and invertebrates. Initially the methods were developed in the Western Province of Solomon Islands, and they have since extended the techniques to other Solomon Islands' Provinces and also Fiji, Kiribati and Tonga. Following a training workshop, villagers in Western Province are now catching and rearing post-larval tropical lobster, cleaner shrimp and fish which they sell to a Honiara-based aguarium fish exporter. Training workshops have been held in Fiji, Kiribati and Tonga. In Fiji a village has been identified with high potential for successful adoption and community members fully trained. Although not at commercial stage yet, the University of the South Pacific is assisting with developing the fishery. Fisheries officers in Kiribati and Tonga also now have the basic skills to determine if the methods have potential for them.

Also in Tonga the **winged pearl oyster**, Pteria penguin, is traditionally used for production of mabe pearls for export market to Japan and elsewhere. This oyster species was introduced to Tonga in 1975 and at the end of 2000 there were 25 small pearl farms. A major impediment to the sustainability and expansion of the pearl industry in Tonga is a reliable and adequate supply of oysters. Over recent years, poor recruitment of spat has resulted in the harvesting of adult oysters from the wild, which has further impacted recruitment, and natural spat fall of Pteria penguin in Vava'u is now extremely limited. A project is focusing on the development of appropriate hatchery culture techniques for Pteria penguin and the use of hatcherypropagated oysters for pearl production. The research will help to optimise culture methodology and pearl production as a basis for sustainable industry development.



Kirbati locals take part in ACIAR-sponsored jewellery making workshop using local pearls

Globally, **horticulture**, **including floriculture**, has become a lead sector for poverty reduction in developing countries. This, however, has not been the case for the Pacific islands. A scoping study investigated the potential for developing the ornamentals industry in the Pacific. While the study specifically covered Fiji and PNG, much of the findings were seen as relevant for the region as a whole. The study found that Fiji's comparative advantage in ornamental horticulture lies in supplying the non-tourist domestic market, and the



Ornamental horticulture and cut flowers offer niche export opportunities in the Pacific

industry had made good progress in realising this opportunity. It has been less successful with respect to the tourism segment which offers the most growth potential. Niche export opportunities have been identified for specialty leaves and for indigenous orchids. By contrast PNG offered some outstanding agro-ecological conditions for cut flowers and foliage, but in terms of export market development these advantages were more than offset by intractable marketing and other constraints. It is highly unlikely that PNG could establish a cut flower export industry comparable to that of East Africa and Central America, but a worthwhile cut flower industry could be built around a significant expansion of the domestic market, supplemented by niche export of specialty products.

Evidence from many Pacific island communities suggests that much **animal manure accumulates** per unit land area, and that lack of proper management of this accumulation can contaminate potable water underground in atolls or in catchments in high islands. Scientists and the people from selected communities are working together to identify practical ways of improving management. A project involving Fiji, Tonga, Tuvalu and Kiribati is leading to improvements for communities in all four countries. In a Tongan village 10 farmers have changed from a free-range extensive system, where pigs roam free in the village and nearby land, to a semi-intensive production system with pigs housed at all times. Farmers, at their own instigation and in association with Ministry of Agriculture staff, are already developing ways to improve the way they feed their confined pigs and developing improved health programs. In Tuvalu there is potential for a positive impact on the environment as farmers change the design of their piggeries as well as their waste management. In both Fiji and Kiribati farmers have begun to use

animal waste as compost in vegetable gardens. There are potential economic gains in all communities through substitution of organic manure for expensive fertilisers, and farmers have also noticed improved soil structure.

A feasibility study has considered initiatives to develop and progress the production of tropical fruits in Tonga. Given its favourable climatic and physical conditions and its relative abundance of suitable land, Tonga would appear to have a comparative advantage in tropical fruit production. The country's geographic position relative to New Zealand and Australia is also an advantage. But the study highlighted the number of subsistence and part-time growers that presently dominate the tropical fruits sector in Tonga, and the lack of diversification of tropical fruits and markets. Given its low productivity levels, there is significant scope to increase the production of the Tongan fruit industry. Some key priorities identified in the study were to improve the prospects of fruit production by introducing new fruit species, replace fruit imports where appropriate, and to develop exports of fruit. But future success depended on capacity building and community engagement.

The search is also on for integrated control of powdery mildew and other disease, weed and insect problems of squash in Tonga. A 2007 field trial for controlling powdery mildew on squash using fungicides suggests there is no resistance to currently available fungicides in Tonga. The GRAS (generally regarded as safe) chemicals tested in Tonga and Australia show consistent effectiveness for the control of powdery mildew of squash. A recommendation will be made on the cost to the Tongan and Australian markets on incorporating GRAS chemicals into the spray schedule, reducing the reliance on fungicides. Another success has been to test the effectiveness of growing a cover crop of Mucuna pruriens (velvet bean) on weed suppression. Crops planted in 2006 and again in 2007 have proven beneficial in controlling weed populations while increasing economic returns from squash cultivation.

Livestock production is an important economic activity in Tonga with 80 per cent of households keeping livestock. Major issues restraining the development of a commercial pig and poultry sector are the lack of a local feed manufacturing industry, the high cost of imported feed and the importation of relatively cheap pig and poultry meat, mainly from Australia, New Zealand and Canada. A project aiming to establish a local feed manufacturing industry hopes to implement some approaches developed in other South Pacific countries and in Indonesia. Three livestock farmers and a government scientist undertook a 10-day study tour to Solomon Islands and Papua New Guinea in August, 2007. Following the study tour all the project partners met in Tonga and agreed to develop suitable feeding systems for pigs and poultry in Tonga, based on what they had observed on the tour. The use of cheaper local feed in the alternative feeding systems could lead to an expansion of the smallholder egg, chicken meat and pork sectors, with these farmers making a significant contribution to the meat requirements of the country.

Subprogram 2: Sustainable management of forestry and fishery resources

A project seeks to address key issues relating to the acceptance of coconut wood into the high-value flooring market. Activities are focusing on development of processing systems and profiles for high-guality flooring, and establishment of appropriate grading standards, product specifications and quality control systems. Project leaders and technical staff conducted several initiation meetings and visits to facilities and palm plantations in Fiji and Samoa. They continue to build a network of interested parties and conduct trials with in-country participants. Project staff delivered a training workshop for cocowood primary processing (supported by The Crawford Fund) in Fiji during September. A project website 'cocowood' (www.cocowood.net) launched in February delivers information and news about the project and encourages



Coconut wood flooring

communication between industry, research and other stakeholders. A network comprising industry contacts in Australia, Fiji and Samoa, including flooring market and production specialists, potential resource suppliers and processors, is now in place.

A good start has been made on two projects that are designed to **underpin good silvicultural practice** in the emerging high value plantation timber industries of Vanuatu and the Solomon Islands. The species involved are whitewood (*Endospermum medulosum*) in Vanuatu and teak (*Tectona grandis*) in particular in Solomon Islands. In both cases, the objective is to develop silvicultural protocols that are compatible with local agroforestry practices. This will involve interplanting with a fast-growing pole species, *Flueggea flexuosa*, in the Solomon Islands, and intercropping with agricultural and horticultural species in Vanuatu.

The particular challenge for another project has been to assist remote rural communities to develop and adopt **sustainable resource use practices for sea cucumber** (harvested for commercial purposes) in an environment where there is often poor understanding of the relationship between fishing pressure and future harvests, where processes for negotiating shared management responsibilities are not well developed, and where there are few alternative sources of income to meet their few, but important, monetary needs. The Government-imposed moratorium on the harvest or export of beche-de-mer (processed sea cucumber) from December 2005 to May 2007 provided the project team with the opportunity to work closely and at length with one community, Kia, in Isabel Province, to provide training and workshops, and to assist the community to draft its management plan for the sea cucumber fishery. The process of 'hastening slowly' has led to impacts well beyond the target community with the Kia community resource management plan leading to development in 14 other coastal communities, along 140 km of coastline. The Kia marine resources management plan has been officially implemented and project-trained villagers are carrying out the monitoring that will feed back into the management practices, using principles of adaptive management. A similar approach was adopted in a village cluster on the west coast of Vella Lavella, in the Western Province. The next steps will focus on scaling out this work to coastal communities throughout Solomon Islands in a follow-on ACIAR-funded project, with the Ministry of Fisheries and Marine Resources and FSPI (a regional non-government community-focused organisation) as partners.

Subprogram 3: Biosecurity and pest and disease management

A forestry project aims to reduce the risk of serious damage to the valuable timber resources of Fiji, Vanuatu and Australia from exotic pests by establishing efficient detection systems in high hazard sites. Some major target pests are the cedar shoot caterpillar, wood and bark beetle pests of pines and hardwoods, lepidopterous defoliators, guava rust and Erythrina gall wasp. Since an initial workshop in 2006 country participants have undertaken static trapping surveys. Although there have been difficulties through a combination of theft/ damage, poor preservation of specimens in the traps and personnel changes, the surveys have yielded specimens that have been



Les Baxter (ACIAR) examines work on the ginger project with plant pathologists in Fiji

positively identified. One of these was of quarantine significance – the Asian ambrosia beetle (*Xylosandrus crassiusculus*).

Ginger farming is an intensive horticultural system practiced in Fiji and Australia. Strategies to control soil-borne pathogens of ginger are under investigation. Scientists believe that central to control of nematodes. as well as the fungal pathogens Pythium and Fusarium, is to create conditions that suppress pests and diseases by increasing soil microbial activity and diversity and improving soil nutrition. Preliminary results from Australian field and glasshouse experiments have shown that carbon inputs from plants and amendments improve the biological status of soils while excessive tillage and fallowing have a negative impact. Suppression of root-knot nematode and to a lesser extent Fusarium was enhanced by amending soil with poultry manure/sawdust, and by reducing tillage.

Both large and smallholder farmers in the Pacific islands grow brassicas, mainly head cabbage, Chinese cabbage and watercress, but their crops are frequently infested with diamondback moth. The use of insecticides is the main form of control, but integrated pest management (IPM) approaches to diamondback moth used elsewhere in the world have limited insecticide use while maintaining control. A trial conducted at Sigatoka research station in Fiji tested a preliminary IPM strategy against current farmer practice and control (no intervention) treatments. The experiment showed that IPM effectively managed the pest complex of diamondback moth and large cabbage moth, promoted natural enemy activity and resulted in crop yields which equalled yields achieved by farmer practice. A refined version of the preliminary IPM strategy will be tested in both Fiji and Samoa in the 2008 growing season.

Subprogram 4: Farming systems economics and marketing

A project has attempted to empirically assess the economic and environmental impacts of agricultural trade liberalisation on the Fijian economy, as well as the environmental
The good oil on sandalwood

As a result of very high prices available for quality heartwood, natural populations of several species of sandalwood (*Santalum* spp.) have been heavily exploited in many countries of the Asia–Pacific region. In most areas, harvesting levels have been well above those that are sustainable. This is the case in Vanuatu, where many populations of *S. austrocaledonicum* are heavily depleted due to over-harvesting.

But recent ACIAR-funded studies, headed by James Cook University in Cairns, give cause for hope that sandalwood agroforestry could be developed as a commercial opportunity for both communities in Vanuatu and indigenous communities of Cape York. In both study areas the scientists have discovered that 3-4 per cent of local sandalwood tree populations possess exceptional oil gualities. These qualities exceed the industry standards set by Indian sandalwood (a different species), making them a valuable resource for the domestication of the species. Until now neither the Cape York nor the Vanuatu species were thought to have trees of this quality.

The project team has embarked on sandalwood domestication projects in Cape York and Vanuatu. The team had a breakthrough in developing techniques of vegetative propagation that offer opportunities for the rapid development of superior cultivars. This new discovery opens a way for local communities to make a greater contribution to the sandalwood industry through planting of these superior varieties, which would then be expected to produce some of the highest quality sandalwood oil in the world.

The project established a 'host' trial in Port Vila (sandalwood is a root parasite and must have a host of another species). Species under trial are *Canarium indicum*, *Casuarina equisetifolia* and *Pterocarpus indicus*. Ni-Vanuatu project participants received instruction in sandalwood plantings establishment, nursery establishment and procedures, sandalwood propagation, plantation establishment and plant improvement.

For a small nation such as Vanuatu, a significant sandalwood plantation estate obviously could make a major contribution to the national economy. It is evident, however, that there is a window of opportunity – if Vanuatu establishes a significant area of successful plantations over the next few years, it will capture the opportunity to ride the wave of high prices; if it delays, then the opportunity will be lost to others. The priority in Vanuatu is therefore to stimulate and promote rapid development of the planted sandalwood industry.

Recognising this, a new ACIAR project is under development, focusing on maximising the adoption of outputs from the earlier project research. It will include the development of a promotion strategy, which will include technical extension material and a prospectus document outlining the investment potential for sandalwood plantings in Vanuatu.

By supporting the development of community sandalwood agroforestry this project can potentially result in positive social, economic and environmental benefits to the people of Vanuatu. Such a move also paves the way for a similar undertaking by indigenous communities in north Queensland.

These activities are significant for the Australian sandalwood oil industry, which stands to benefit through future access to a consistent supply of the high quality oil necessary for producing premium branded products.



Sandalwood growers in Vanuatu

effects of increased agricultural production and trade. In one study the research team calculated that the **economic cost of soil degradation** to cane farmers and the sugar industry was an estimated US\$8 million per annum, while the industry also lost about US\$12 million in sugar sales per annum. Despite the high economic cost of land degradation to farmers and the significant external costs it imposes on society in general, soil conservation was very low on the government's policy agenda. The project team recommended a more comprehensive study of the issue of land degradation prior to developing policies to address the problem.

Nurturing horticulture opportunities was the driver for a unique collaborative venture between the Queensland Department of Primary Industry and Fisheries and the Samoan Ministry of Agriculture and Fisheries. The project is benefiting both indigenous communities in Cape York Peninsula and in Samoa with reports of increased production of horticultural products among both the communities. The project was designed with twin objectives in mind: to foster the sustainable development of horticulture to supply local and distant markets and to enhance capacity for the development and use of technical information by researchers, extension personnel and farmers. It began with identifying the current information constraints to horticultural industry development for remote communities, the key commodity interests for each community and progressed through to production of a range of grower information on production, marketing and cultivar identification, harvesting and grading as well as a series of health and nutrition factsheets (for 18 food crops including taro, papaya, bananas) for growers and consumers and extension staff in Samoa and other Pacific countries.

South-East Asia

Financial year	Regional expenditure	Percentage of total project expenditure	Commission target as percentage of expenditure
2007–08	25,645,120	59.9%	>45%
2006–07	21,586,153	54.8%	>45%
2005–06	17,319,348	49.3%	>45%

South-East Asia is the largest of the five regions in which ACIAR conducts research activities, with eight countries involved, and will remain our largest partner both within the region and of all our partner countries. For the region an expenditure target of more than 45 per cent of our overall annual project expenditure has been set.

Indonesia	38
Vietnam	52
Philippines	61
East Timor	69
Cambodia	71
Lao PDR	76
Thailand	81
Burma	83



Indonesia

AOP budgeted expenditure in 2007–08	\$11,909,632	ia con
Actual expenditure in 2007–08	\$11,877,511	e Meye Itry dones
Expenditure in 2006–07	\$9,673,583	ien de Coun ger, In
Expenditure in 2005–06	\$6,245,959	Mr Jui ACIAR Mana

Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007-08
Evidence of contribution of ACIAR projects designed to the Australian–Indonesian collaborative effort on improved fisheries management and illegal fishing	Research findings and policy networks on shared fish stocks continue to support constructive dialogue between Indonesia and Australia aimed at establishing agreed joint management arrangements for key fishery resources. Red snapper is the first stock selected for consideration. A new project is consolidating the earlier effort and exploring innovative frameworks for the management of Indonesia's complex domestic fisheries, including the reduction of IUU fishing.
Enhanced 'best-management' practices developed and implemented across several aquaculture production systems	Best Management practice (BMP) husbandry packages have been developed and validated for several different shrimp production systems. A regional project is now in place with the Network of Aquaculture Centres in Asia to foster the timely exchange of information between countries. BMPs for freshwater and marine fish cage aquaculture are under development.
Better soil management methods for tsunami-affected soils recommended by BPTP and Dinas groups and in use by farmer groups in Aceh	Promising management practices such as application of manures, use of salt-tolerant crop species and improved crop rotations have been identified to reclaim and increase productivity of tsunami-affected soils. Field demonstrations have been conducted in close collaboration with the Assessment Institute for Agricultural Technology, provincial and local government and farmers.
Evidence of information flow from animal health projects into Indonesian Government policy-making on avian influenza	Strong participation from Indonesian researchers and government animal health system in a large ACIAR–Indonesia avian influenza program, including components aimed at institutionalising incident response. Staff turnover at senior levels delayed policy making.
Successful implementation of the adaptive research component of the Smallholder Agribusiness Development Initiative (SADI).	Fourteen new adaptive research projects commenced in Eastern Indonesia under SADI in 2007–08, representing completion of design and implementation of the research component in the first phase of SADI.

Key performance indicators	Performance 2007–08
Improved seed systems assessed by the Indonesian potato industry	Discussions were held with the Indonesian potato industry on proposed ways to improve seed systems. Training workshops on seed potato care, handling and seed certification undertaken in early 2008 included, at industry request, additional information on ways to manage potato cyst nematode.
At least 40 per cent of new projects designed with potential for significant farmer or policymaker impacts within five years of completion	Fourteen of the 17 new projects commissioned in 2007–08 fell into this category.

Position

In 2007–08, the Indonesia program applied research to support economic growth from agriculture, forestry and fisheries in Java and parts of Sumatra and eastern Indonesia. It maintained a focus on high-value commodities (for which there is strong market demand) that are identified as priorities by the Indonesian Government and for which major constraints require attention through research, although under ACIAR-SADI projects were initiated to tackle staple crops such as rice and legumes as these are critical for food security in Eastern Indonesia.

ACIAR also addressed related pest and disease management, including shared biosecurity concerns, postharvest processing and market development issues. Protection of the resource base for agriculture will be assisted by research collaboration on aspects of crop and livestock bio-security and sustainable forestry and fisheries management and through policy research on effective engagement in markets. A range of training and technical projects continued to assist in fisheries and agricultural rehabilitation in Aceh, affected by the December 2004 tsunami. The program built linkages between research agencies in agriculture, forestry and fisheries and policy/ implementation directorate-generals, and supported cooperation between central institutes and provincially based agencies.

Achievements

Subprogram 1: Improved policies to underpin agribusiness development

Public and private sectors in Indonesia commonly use farmer groups as a structure through which they invest resources and implement development programs. A recent study aimed to understand how the behaviour of a group and the group leader can influence the group's provision of marketing support and its choice of selling method. Researchers used modelling to evaluate **the role that social capital plays in facilitating cattle smallholders' access to market opportunities**. They identified what specific characteristics of cattle groups and their leaders enable group members to successfully



Many farmers in Indonesia still use traditional farming methods

access cattle market opportunities in the important cattle-producing regions of Bali and Lombok. The study found that most farmer groups preferred to sell on-farm, and that those that preferred to sell at the market tended to focus more on cattle price and productivity and used group and leader strengths to sell cattle this way. The study also found great similarities between farmer groups in Bali and Lombok even though they were culturally and economically different.

The costs of the recent outbreaks of avian influenza (AI) in Indonesia have not only been in lives lost and birds culled and also economic disruptions and wider potential flow-on to tourism. A project to quantify the full economic costs of bird flu through socio-economic research is well underway with findings and information keenly sought by agencies dealing with AI control. The research benefits funding decisions and policy responses and helps guide the national efforts to manage AI with a focus on integrating human health, bird management and indirect consequences to industries such as tourism. Four household surveys have been undertaken involving Balinese and Lombok medium-size producers of broilers and layers and Balinese and Lombok smallholder producers of kampung chickens. The survey work has been supplemented by interviews with upstream and downstream agents and government officials and a computable general equilibrium model capturing the indirect economic effects of the avian influenza epidemic based on secondary data has been developed. Workshops have further disseminated the project results.

Another policy project is **assessing technical change in Indonesian agriculture** to identify agricultural industries that have shown productivity growth and determine why they have grown. The project, also underway in Thailand, is also looking at the economic and social effects of the technological change, including effects on agricultural trade, income distribution and poverty. The Indonesia team made substantial progress with assembly of the data set on agricultural inputs and outputs which will be used for statistical analysis of the nature of technical change and with the general equilibrium analysis of the social and economic effects of technical change in Indonesian agriculture. Modelling problems encountered have proved to be helpful in training project participants in the rigorous testing of national general equilibrium models for consistency.

Subprogram 2: Biosecurity cooperation and pest and disease management in agriculture and plantation forests

A. Animal diseases

The ACIAR–Indonesia avian influenza and zoonotic disease research and development program was implemented during this period. The program of targeted initiatives aims to provide necessary underlying research required to implement effective control programs for HPAI. The \$8 million program is closely aligned to Indonesian Government, AusAID and other donor priorities for control of the disease and include underpinning research on:



Intensive broiler farm in Lombok



Collecting and unloading broilers for wet markets in Lombok

- economic impacts of the disease which are being defined by household and enterprise survey to inform policy decisions on disease control approaches.
- ducks which are considered to be a reservoir host of the virus and therefore important when control programs are being implemented. The patterns of the disease spread and response to vaccination in the duck are being investigated.
- the virus that causes avian influenza

 which is capable of changing its surface structure over time and the influence of this on the effectiveness of vaccination is being monitored.
- the movement of birds which is an important means of virus spread and knowledge of this spread is critical for implementing regional or island control programs.
- effective quarantine procedures for individual enterprises – which will be tested in collaboration with the commercial poultry sector in Indonesia. While the

Indonesian Government has initiated significant control programs, to be effective they must be implemented by the community. ACIAR helped to address this through a scoping study to define the non-integrated commercial poultry sector and identify the factors influencing its economic and social sustainability. A new project has now commenced to foster adoption of least-cost biosecurity measures throughout the entire Indonesian poultry industry. It involves case study areas in Bali, South Sulawesi and West Java where project participants will record the levels of within-community adoption of project outcomes. The project will also study the market chain to ensure that the biosecurity measures suit the cultural and institutional characteristics of the market.

Problems encountered in national programs to control avian influenza prompted the Indonesian Government to approach ACIAR for assistance in **strengthening veterinary services**. In light of the recent increased decentralisation of government services,



Bunch of bananas cut open to reveal symptoms of blood disease

ACIAR sponsored an investigation into possible future directions for animal health services, both systemically and with specific disease entities. The study addressed five diseases of primary concern – avian influenza, anthrax, brucellosis, rabies and the transboundary disease of pigs and classical swine fever. The integration of activities and resources of stakeholders was the likely key to strengthening government veterinary services. Strategies to be developed and tested were pilot projects on priority diseases using integrating task force structures, activities to enhance the coordination role of provinces, strengthening capability at district and sub-district level, and more clearly defined roles of all stakeholders.

Diseases transferred from animal to

humans (zoonoses) are an ongoing concern in Indonesia. A study identified the important zoonotic diseases, attempted to quantify their costs to the nation and then recommended research to address issues presently limiting effective responses and control. The team identified the highest priority diseases as brucellosis and cysticercosis followed by toxoplasmosis and avian influenza, and lastly anthrax and rabies. Many of the suggested disease-specific research involved recurring themes – disease surveillance, effective control programs and training of animal health staff at different levels in principles of epidemiology and surveillance.

ACIAR has made a significant investment in the **study and control of Jembrana disease**, an acute viral infection of the Bali cattle species dominant in Eastern Indonesia. One major outcome is the development of a recombinant protein subunit vaccine for which it is anticipated that a vaccine company in Indonesia will manufacture and distribute under licence. Work continues towards the development of specific serological tests to aid in Jembrana disease diagnosis and control.

B. Crop and forest pests and diseases

As a result of **a study of fruit flies** in 16 provinces of Indonesia, scientists and policymakers now have access to a list of species occurring in these regions. Staff at the collaborating institutions received training in fruit fly surveillance techniques. This training helped members of the Food Crops and Horticulture Protection Centre to establish a fruit fly trapping network in six provinces. A controlled environment fruit fly rearing facility at the Pest Forecasting Centre in Jatisari now supplies flies for attractancy testing of protein baits, and a protein bait plant is now functioning at the PT MultiBintang Brewery in Tangerang. A workshop held in mid-2007 has provided Indonesian guarantine and crop protection staff with knowledge of how to define a fruit-fly-free area, how to maintain it and the costs involved in dealing with the eight major fruit fly pest species in Indonesia.

The banana industry in Indonesia has been hard hit by two diseases - Fusarium wilt and blood disease. Two projects are in progress, focusing on Indonesia but also Papua New Guinea where there is a potential problem. The projects have improved the understanding of the diseases and the diagnostic tests for detecting them. Extension agencies and the Indonesian Banana Wilt Task Force have been instrumental in sharing the best practice management options for wilt diseases with farmers. Scientists in the first project have developed improved diagnostic tests to detect the diseases, and have established a best-practice management regime which they are demonstrating to farmers. The second project is working to learn more about Fusarium wilt disease and aims to map the



Project staff discuss on-farm disease management with banana growers

geographic spread of the wilt in its various forms. Help is at hand through resistant plant varieties, biocontrol, and use of low-cost tissue culture for planting disease-free bananas and undertaking routine surveillance. The recipe for success is going to be the participatory approach by involving farmers right from the start in the development and validation of disease-management strategies.

Another key project has investigated the integrated disease management of the Chilli pepper (Capsicum spp.) for Phytophthora, anthracnose and gemini viruses. Three important chilli production regions in Central Java were selected for baseline survey and evaluation work of this important cash crop. A site coordinator's office has been established in Tegal and Rapid Rural Appraisals were conducted and several trials were carried out in farmers' fields, including crop management trials to evaluate a combination of plastic mulch, bio-fungicide, or synthetic fungicide and also physical barriers to reduce whitefly movement. Total yields of plots with the high barrier and insecticidal sprays were more than double that of untreated plots that simulated conventional farmer practice. Unfortunately, losses to anthracnose in this trial exceed 50 per cent of the harvested crop, regardless of treatment. Researchers are already seeing local growers imitating this treatment by erecting barrier walls of various sorts around their chilli gardens. Some 225 farmers have been included in the baseline survey work and household surveys are also being completed. Pathologists at The World Vegetable Center in Taiwan have collected isolates of Geminivirus pathogens, which are being used in focused studies of virulence and symptom expression.

As the Asian **citrus disease, Huanglongbing** (HLB), is spreading and threatening the region's production, an ACIAR-supported project is helping to develop control strategies for the disease. While white oil and insecticide were effective, they proved to be too expensive for the small farmers. So researchers turned to insect predators and are also trialling intercropping orange trees with guava



Improved pest management is enhancing citrus production in Indonesia

trees. While trials have suggested that the presence of guava suppress citrus psyllids that carry the bacterial disease, guava leads to another problem of fruit flies. While work continues, a mix of controls (weaver ants, oil and guava) has shown to be benefitting growers in their orchards.

Indonesia is one of a number of South-East Asian countries trialling and adapting the Integrated Ecological Rodent Management system. The concept has been refined over a decade by ACIAR and CSIRO Sustainable Ecosystems though nine projects and across five countries The National Rodent Management Program in Indonesia has now been developed following the ACIARsupported research in West Java, allowing villages to reduce rat numbers and crop losses. At trial sites, yields increased by between 0.1 and 0.9 tonnes a hectare and farmers using chemicals fell to 46 per cent. Yields at control sites did not rise and chemical usage remained constant at 88 per cent.

Subprogram 3: Research to underpin development of competitive horticultural agribusinesses

Research, development and extension work to support the **development of potatoes and rotational crops** has made significant progress with two projects focussing on growing potatoes as cash crop. Integrated crop management Farmer Field Schools have been established in 10 communities in West Java and 10 communities in Central Java as part of a project to develop potato, Brassica and shallot production and postharvest systems in the provinces of West and Central Java, South Sulawesi and Nusa Tenggara Barat. The crop management and economic baseline survey for the first potato crop was completed and analysed with key findings on soil and nutrient data providing information to enhance yields. A second project focuses on improving the organisation and efficiency of the supply chain and finding new ways for horticulture crop farmers to access the supply chain and markets. The project will use a participatory market chain approach. In earlier applications by the International Potato Center, the approach has built trust between stakeholders, promoted collective action and stimulated market-driven innovation. The project will ultimately see farmers participating in two specific types of supply chain: fresh-product markets involving assemblers/wholesalers/retailers/ institutional buyers and processed-product markets including chip factories and snack food enterprises.

Subprogram 4: Productive smallholder aquaculture and agroforestry systems

Developing carbon markets to help lower greenhouse gas emissions is a concept gathering momentum around the world. An ACIAR-funded economic study in Indonesia



Bali fruit market



Training for aquaculture rehabilitation in Aceh

has explored the potential for smallholder agroforestry to gain multiple benefits – reduce deforestation, lower CO2 emissions, and reduce smoke-induced health and pollution problems from slash-and-burn agriculture. The study found that smallholders lacked the credit to plant trees and wait the considerable time before income is generated. Often they had no security of tenure on the land they farmed. Researchers recommended that carbon credits be sought to provide funding and that farmers gain economies of scale for their agroforestry enterprise by grouping together and pooling land resources.

Research supported by ACIAR has developed **best-practice health management practices for shrimp farmers** including polymerase chain reaction (PCR) and epidemiological tests to identify white spot and other diseases which can be devastating for small farmers. Building on important partnerships and experiences from a predecessor project, this project has taken a two-pronged approach with laboratory work and field work. At field level, the researchers delivered training to farmers using demonstration ponds operated by leading farmers. Groups of farmers have successfully produced several crops of high-quality shrimps and researchers know more about best management practices suited to traditional famers. Laboratory work has expanded understanding of yellowhead virus and detected Laem Singh virus, a possible causal agent for Monodon slow growth syndrome in black tiger shrimp from Indonesia, Malaysia and Vietnam.

Another key aquaculture project has targeted the improvement of returns and expansion of the aquaculture industry into land-based systems by studying site selection and environmental suitability of aquaculture ponds. Solid progress has been made with the completion of fieldwork, data analyses, production of draft site selection criteria and associated draft land capability maps. The work forms the basis for production of informative land classification schemes and maps for a variety of land-based aquaculture systems in Indonesia. Farmer- and districtbased workshops have been held to plan community extension programs. The project also co-developed mapping models for another seacage farming project and has also developed links with another disease management project with the integration of information on pond management to minimise the effects of soil and water quality on disease outbreaks.

Shrimp farming can be profitable and sustainable and access opened to export and premium domestic markets through the proper management of biosecurity and compliance with product quality and food safety standards. A linked project has developed and validated model programs combining better management practices and participatory extension methodologies. Extension and health management services will work at district and provincial levels to facilitate BMP adoption among four selected farmer groups: two in Central Java and two in South Sulawesi and complementary programs for broodstock suppliers, hatcheries and 'middlemen'.



Tiger grouper floating net cages

A study of hatchery and growout technology for marine finfish in the

Asia-Pacific region has a major component underway at the Research Institute for Mariculture in Gondol. Results include the finding that additional vitamin C helps to reduce deformities in larval and juvenile grouper. As well, researchers have isolated and evaluated different rotifer strains. determining that the smallest strain was best suited for first feeding of grouper larvae. At Maros in Sulawesi, scientists evaluating feed ingredients found that tiger grouper could efficiently digest animal feed ingredients, holding promise of their potential to replace fish meal. At Labuange Bay in southern Sulawesi three treatments of fish feed (trash fish, moist pellet and commercial pellet) are being evaluated and compared on five commercial farms growing tiger grouper.

Suitable **diets for cultured mud crabs** have been studied in Indonesia, as well as Vietnam and Australia. As with the marine finfish, scientists wanted to determine the potential of poultry meal and soybean meal to replace fishmeal in diets of juvenile mud crabs. Crabs were able to readily digest a broad range of plant- and animal-based feed meals. In trials, up to 40 per cent of fishmeal could be replaced by high-protein plant- or animal-based meals without significantly reducing growth performance.

A feasibility study undertaken on the island of Lombok investigated how to improve growout and nutrition in lobster aquaculture. The industry has developed as a by-product of grouper and seaweed culture which both involve floating rafts to which the juvenile lobster are attracted. The study team concluded that there was an opportunity to expand the industry in Lombok, guided by research for the industry in Vietnam that has taken place through other ACIAR projects.

Subprogram 5: Sustainable utilisation and management of fisheries and forestry resources

For more than 400 years teak has grown in intercropping systems as a common part of local farming systems in South East Sulawesi. Emerging community involvement in forest management in line with changes in Indonesian Government policies will help to **increase the planted areas of teak**. A recent study will guide ACIAR and Indonesian counterparts in planning its assistance for smallholder teak growers. Opportunities include establishing reliable inventory systems, improving cultivation options and intercropping alternatives, primary processing of timber and use of log off-cuts, and in testing the suitability of alternative plantation species to grow in association with teak.

In a project designed to optimise the gains possible from genetically superior tree **species**, scientists are determining nutrient and water needs for best performance. Target species are Acacia mangium and A. crassicarpa, and trial plantation sites have now been successfully established in Indonesia and Australia. In both countries, only limited information exists on soils, and outcomes from this project will contribute knowledge on soil chemistry from the focus areas. Performance of the best available genetic material is being assessed across a range of phosphorus (P) supply treatments (which also include basal nutrients), and in a high P treatment without basal nutrients. In another part of the project, a sociological study has surveyed small farmers to determine the factors limiting adoption of A. mangium plantations.

Subprogram 6: Profitable agribusiness systems for eastern Indonesia

As a partner in the **Smallholder Agribusiness Development Initiative (SADI)**, ACIAR is supporting the development of more-profitable agribusiness systems in eastern Indonesia through better access to new knowledge underpinning improved production and marketing of agricultural products. Responding to priorities of the four target provinces, ACIAR's component of SADI (Support for Market-driven Adaptive Research: SMAR) completed 11 new scoping studies and



A farmer inspecting seedlings as part of crop trials in Indonesia

commenced 14 market-oriented adaptive research projects in 2007–08. The 20 active projects under SMAR, with a total committed value of \$8.7 million, involve research on livestock, horticulture, forestry, aquaculture and field crop systems as well as agribusiness development. In support of these activities, over 400 training opportunities were provided to Indonesian R&D staff in research management, research skills and specific technical skills, aimed at building individual and institutional capacity to conduct adaptive research and communicate the outcomes to next users.

Active SMAR projects, involving partners from national, provincial and local institutions and a number of different private sector organisations, are addressing key constraints within the supply chains to improve **supply chain competiveness and smallholder profitability**. While covering several commodity sectors, the projects capture key globally relevant themes for smallholder agribusiness systems including:

- supplying increasing demand for animal proteins, such as scaling out appropriate livestock productivity technologies;
- smallholders benefiting from high value products, such as improved supply of aquacultured lobsters;
- using regionality as a competitive position, such as capitalising on South Sulawesi passionfruit being recognised as unique throughout Indonesia; and
- more efficient input management for improved terms of trade, such as the use of alternative feed options for cattle production and improved capacity for changing practice.

Linkages with specific agribusiness supply chains are being developed with the assistance of another partner in SADI, the International Finance Corporation (IFC). Working with provincial governments, IFC is identifying lead firms linked to high-priority agribusiness supply chains in eastern Indonesia and partnering with those firms to improve supply chain efficiency. At the same time as IFC identifies lead firms, ACIAR is developing research activities to address significant productivity and profitability issues in those supply chains. Peanuts, for example, are a significant cash crop for farmers in Lombok, grown on 37,000 ha following the main rainfed grain crop. IFC has partnered with a major peanut buyer and processor in eastern Indonesia, GarudaFood, to improve farmers' access to markets, finance and technical support. GarudaFood currently sources peanut from 3,500 farmers but, through the partnership with SADI, plans to expand to 18,000 farmers. An ACIAR project is supporting this work by working with the farmers linked to GarudaFood to address the significant technical issues affecting productivity and profitability, including access to good quality seed, new varieties, poor management practices and water management.

Another sector, cocoa, is the main source of income and livelihood for over 500,000 smallholder households and contributes significant foreign exchange earnings. However, the quality and productivity of cocoa is in decline due primarily to pest and disease pressure, aging tree stock and declining soil fertility. Farmers are experiencing total losses of up to 50 per cent of their potential production. ACIAR is supporting research to address these key technical issues in partnership with IFC who are supporting an industry forum (the Cocoa Sustainability Partnership) and identifying lead cocoa agribusinesses with which they can work.

ACIAR is also directly funding research aimed at strengthening agribusiness supply chains by improving both productivity and supply chain efficiency. One of the 20 new projects under SMAR is developing strategies for making the eastern Indonesian smallholder beef sector more competitive and profitable by benchmarking beef supply chains. The project is specifically targeting the benchmarking to areas of eastern Indonesia where ACIAR is also funding research to improve the productivity of Bali cattle (through improvements in feeding, mating, cow-calf management and husbandry). In particular two large projects are focusing on improving management approaches and effective linkages to markets so that smallholder Bali cattle producers can move from being opportunistic keepers of livestock to market-oriented producers. In West Timor, studies are in progress to integrate forage legumes into the maize cropping system. A major aim is to augment supply of quality fodder for livestock and ensure availability towards the end of the dry season. Project scientists have already identified some suitable forage species which are now undergoing on-farm assessment. It is critical to ensure that forage production becomes self-sufficient in supply of seed, and this milestone was reached in the first year of the project. Efforts are now underway to produce seed commercially.



Farmers harvesting small-scale community crops in Indonesia

As well as funding research projects to help improve the profitability of agribusiness systems in eastern Indonesia, ACIAR is **building the capacity of the Indonesian R&D system to conduct research oriented towards more profitable agribusiness systems**. ACIAR's main partner agency in SADI (the Indonesian Centre for Agricultural Technology Assessment and Development: BBP2TP) is beginning to implement best practices from the partnership with ACIAR to an additional 14 provinces outside of the SADI target provinces, using their own resources. ACIAR will assist the piloting of this scale-out.

A project has examined how **seasonal climate forecasting** could lead to better irrigation system management in Lombok. The scientists modelled water availability throughout the system, taking into account different climate, water, land and institutional constraints. They determined that significant economic gains could be realised through water allocation and cropping decisions at a scale suited to Lombok's small farms (0.25 ha on average). But a major issue encountered was that farmers growing crops on farms of this size are risk-averse, leaving them reluctant to adjust cropping patterns on their farms on the basis of the available climate information.

Subprogram 7: Technical cooperation to underpin post-tsunami rehabilitation of agriculture and fisheries

Efforts to restore annual cropping in tsunami-affected areas of Nanggroe Aceh Darussalam Province continued. Field activities focused on monitoring changes in soil salinity during the post-tsunami period. At 20 sites across the districts of Aceh Barat, Aceh Besar, Pidie and Bireuen soil salinity is declining and is now a less significant limitation to crop production than during the first year after the tsunami. As part of the need to introduce improved agronomic and nutrient management practices, the scientists have established 10 research and demonstration trials for soybean, rice and peanut crops. These have examined soil and crop issues, especially cropping techniques



The Prime Minister of Australia Mr Kevin Rudd together with the Governor of Aceh province, officially opened the Regional Brackish-water Aquaculture Development Centre, at Ujung Batee, in Indonesia's Banda Aceh province, on 14 June 2008.

to manage tsunami-related problems, and have led to selection of best-suited varieties (especially for salt tolerance in rice) and promotion of integrated crop management.

A key multilateral project is conducting a **vegetable research and development project in the tsunami-affected areas** of Indonesia. The vegetable production technologies will be shared with thousands of Indonesian farmers to enable sustainable, long-term development in tsunami-affected areas. Vegetables with medium to high salt tolerance likely to have an advantage in affected soils—tomato, cucumber and cauliflower—have been identified and the soil analyses completed. Two farmerparticipatory research trials have been completed and another three initiated. Work has also begun on analysis of the baseline survey (focused on chilli pepper and other vegetables, with comparisons to rice) conducted in eight villages across five Districts. A Short Course was run in Banda Aceh and preparations are underway for a Vegetable Integrated Crop Management Workshop and training of trainers. The project is having a positive impact on the rural communities and farmers are interested in being involved.

Another major sector affected by the Tsunami was aquaculture. The Food and Agriculture Organisation (FAO) estimates that about 20,000 hectares of coastal aquaculture ponds were damaged or destroyed. The Australian Government is rebuilding the Brackish-water Aquaculture Development Centre at Ujung Batee as part of the Australia–Indonesia partnership and has funded a program to build the capacity of staff. The ACIAR-delivered capacity building project will support the reconstruction of coastal aquaculture and also the longer term development of sustainable aquaculture. Staff have been trained in laboratory techniques, including polymerase chain reaction (PCR) techniques to test for shrimp and fish viral diseases. A joint ACIAR-ATSE Crawford Fund training activity has assisted in the development of improved disease monitoring and diagnostic practices for aguaculture in Aceh. An extension to the project will allow facility- and field-based training to be completed as planned, and will support a staged transfer of full management responsibility for ongoing project activities to staff. The Australian Prime Minister, Hon. Kevin Rudd, MP, visited and officially opened the reconstructed facilities of BBAP Ujung Batee in June 2008. This event was very successful in showcasing this part of the Australian aid program in Aceh not only to the Australian Prime Minister, but also to the local community and senior government representatives.

Restoration of annual cropping in tsunami-affected areas of Nanggroe Aceh Darussalam Province, Indonesia

Agricultural soils affected by the 2004 tsunami in Aceh are now more productive thanks to a joint project between ACIAR, NSW Department of Primary Industries, Aceh's agricultural extension service (BPTP), the Indonesian Soil Research Institute (ISRI) and the Indonesian Centre for Rice Research (ICRR). The project rebuilt and strengthened the technical capacity of Aceh's agricultural extension staff, and developed and demonstrated soil management practices to restore farm productivity.

The project established 21 monitoring sites in four districts—Aceh Barat, Aceh Besar, Pidie and Bireuen—to monitor soil salinity and nutrients and their impact on crop production. The laboratory at BPTP was repaired and upgraded to enable on-site soil and water testing. The project provided EM38 instruments and soil test kits, and trained BPTP staff to enable rapid on-site assessment of salinity levels and soil and crop problems, so that farmers did not waste time and resources growing crops in unsuitable soils. Train-the-trainer workshops extended this training to extension staff and NGOs from tsunamiaffected districts. Field trials were established to investigate techniques to reduce tsunami-related soil and agronomic constraints and field plots demonstrated technologies and practices that improved yields of rice and palawija crops such as soybeans and maize. ISRI provided soil sampling, analysis and mapping expertise and ICRR assisted with trial design, seed supply and biometric analysis, and conducted pot trials. In most areas, salinity levels dropped relatively guickly because Aceh's high rainfall leached the salt through the soil profile. However, many crops continued to have lower yields than before the tsunami, possibly due to removal of organic matter by the tsunami, and reaction of seawater and soil minerals.

The death toll from the tsunami destroyed many social networks, so building

communication networks between farmers and government and NGO agricultural groups was also a high priority for this project. Annual communication forums established networks between researchers, extension staff, NGOs and farm leaders. Participants presented and discussed issues relating to farming on tsunami-affected land in Aceh. NSW DPI introduced techniques to encourage debate and discussion among all participants at these sessions. Project staff met with farmers in the field to find out what agricultural information and assistance they needed. West coast farmers travelled to other districts to learn techniques from farmers growing crops in peat soils, as peat soils are prevalent in Aceh Barat. This exercise was greatly appreciated by the farmers. Women's farm groups were identified as a very important aspect of tsunami recovery. providing important social networks, occupation and income for the women who otherwise had few outlets in their traumatised communities. The local and Australian project team members have all reported that working with committee and enthusiastic partners and extension workers is one of the reasons that this ACIAR project in Aceh is so enjoyable and so successful.

The project also linked with an Asian Vegetable Research and Development Corporation project to restore vegetable cropping in Aceh's tsunami-affected soils. Printed information about the progress of research and extension on tsunamiaffected agriculture was presented in a regular newsletter, a project brochure, and a web page: http://www.agric.nsw. gov.au/reader/wollongbar/aceh.htm. Feedback from workshops and forums assisted the development of accessible materials for farmers and extension staff. A major output of the project will be an online manual to help people restore agricultural land after future tsunamis.

Vietnam

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AOP budgeted expenditure in 2007–08	\$3,185,862	anage
Actual expenditure in 2007–08	\$2,708,237	orris, try Mc
Expenditure in 2006–07	\$3,145,372	off Mc Coun
Expenditure in 2005–06	\$2,856,742	Mr Ge ACIAR Vietno

Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
Linkages between ACIAR-funded research and AusAID-funded development continues to be fostered	ACIAR program shift to support two 'lagging regions', including those with significant ethnic minorities, aligns closely with AusAID-funded national poverty reduction support programs. Several AusAID Collaboration for Agriculture and Rural Development (CARD) projects commenced in 2007–08 closely link with current or concluded ACIAR projects.
New training and information exchange activities in biosafety and biotechnology regulation undertaken	Key Vietnamese scientists and policymakers supported to attend targeted training run by the Asian Institute of Technology in December 2007.
NGO and community organisation linkages established in at least three projects	NGOs involved in three active projects: World Vision: soil management and cattle-raising; Oxfam: pig marketing; and Vietnam Women's Union have a leadership role in work on indigenous vegetable production and marketing.
Programmatic shift to emphasis on better processing technologies for two timber species leads to development of higher- value forest products	Significant progress made on research on sawing of young eucalypts. Emerging interest in utilisation of acacias for sawn timber in Vietnam. Commence- ment of project on developing silvicultural systems for acacia sawlog production delayed until July 2008.
Enhancement of quarantine capabilities in fumigation and plant disease diagnosis	Six workshops on phosphine fumigation held throughout Vietnam, which assisted in imple- menting new national fumigation standards. Fumigation manual was prepared in Vietnamese. A project on plant disease diagnosis increased diagnostic and plant pathology skills of researchers and extension workers in central Vietnam.
Enhancement of Vietnamese capacity in aquaculture of high-value species	Development of diets for mud crabs successful at laboratory scale. Research on oysters and other edible molluscs led to an increase in hatchery capacity.
40 per cent of new projects designed to have significant farmer or policymaker impacts within five years of completion	Three of the four projects commenced in 2007–08 (trade liberalisation; indigenous vegetable production; marketing and mollusc hatchery technology) were designed to have significant policymaker or community impacts within five years of completion.

Position

In 2007–08, the main focus of the ACIAR Vietnam program was research to assist the enhancement of smallholder incomes. A number of activities fostered the development of higher value crop and livestock products, as well as improving market access through the improvement of the safety and quality of agricultural products and strengthening biosecurity. Collaboration in fisheries research cooperation focused on aquaculture and mariculture, while forestry cooperation will have an increased emphasis on silvicultural management and processing to produce higher value products and value-addition. Natural resource management research activities focused on sustainable cultivation systems for poor soils in central Vietnam and on water conservation. Close linkages to two AusAID-funded programs (Collaboration for



Agriculture and Rural Development (CARD) and the Quang Ngai Rural Development program) continued, although 2007–08 saw the last call for new CARD proposals and the conclusion of the current phase of the Quang Ngai program.

Achievements

Subprogram 1: Increasing market competitiveness of Vietnamese agricultural and fisheries products

A: Better policy interventions for meeting market specifications and opportunities

Vietnam has achieved remarkable economic growth since it liberalised its markets, and further economic growth and opportunities are predicted both within and outside the agriculture sector. With some 70 per cent of the population still living in rural areas, Vietnam's integration into the global economy is likely to impact rural incomes. A new project will assess the structural **adjustment issues associated with trade liberalisation**, using quantitative economic models, and will involve identification of vulnerable groups and industries and assessment of domestic policy options for facilitating structural adjustment.

While agricultural research and extension are increasingly being viewed by the Vietnamese Government as priorities, an ACIAR project is addressing Vietnam's need for enhancing project impact and science capability through a robust evaluation framework necessary for public accountability. Australian project evaluations suitable to Vietnamese were identified together with guidelines for trialling on selected projects. Training was delivered to the Vietnamese evaluation officers in Vietnam and case studies developed. **Concept Mapping Workshops generated** a series of indicators which were mapped against the Science Capability identified through the research process. Using the Australian Business Excellence Framework as a guide, a Science Capability Framework was also developed. The Evaluation Model developed by the project is now being implemented and is in effective use in Ministry of Agriculture and Rural Development's R&D projects.

In a major ACIAR project (covering Indonesia and Vietnam) that could prove critical to the way avian influenza is tackled, researchers are looking at small-scale Vietnamese famers to study transmission of H5N1 in domestic ducks. Most of the birds in Vietnam were reported to be vaccinated. It was reported that 60 per cent of vaccinated ducks and 39 per cent of vaccinated chickens had protective antibody levels and no mortality due to HPAI. Chickens responded to vaccination later than ducks and had lower antibody levels. Results suggest that protective levels of immunity in all birds after vaccination is not necessary to prevent disease outbreaks and reduce mortality. Vaccination status, the presence of other poultry species kept on the farm, and the sharing of scavenging areas have been identified as risk factors for disease



Extracting blood from ducks to source the spread of avian influenza in the Mekong delta

outbreaks. Overall the project is confirming that ducks are important in outbreaks of HPAI, that they can respond to vaccination, and that nomadic flocks are significant in the spread of infection. The researchers are hoping to be able to develop recommendations for authorities about the role of ducks, how vaccination might work best and how infection in ducks could be effectively monitored. There has been wide media coverage and extension work throughout Vietnam and a well-delivered public health message.

A new project is addressing the rapid increase in demand for pork in Vietnam. Successful commercial smallholder pig farming may help to meet the demand while alleviating some of the country's widespread rural poverty. The project is looking at **changing dynamics of the pig sector** and the technology, policy, market institution or coordination options that will give smallholder pig producers in Vietnam better access to higher-value market chains and niche markets. The project team met with a wide audience of key stakeholders including policymakers, non-government organisations, researchers, pig producers, and donor agencies at a project inception workshop. This was followed by a series of participatory rapid appraisal surveys to provide a broad characterisation of the existing pig supply chains and two major detailed surveys on consumers and producers. The project team has also expanded with the participation of two more NGOs and linkages with other livestock-related initiatives to ensure a pathway for uptake of project outcomes.

B: Enhanced quality and reduced losses in crops and forest products

A concluding project to improve the skills in diagnosis, extension and control of crop diseases in central provinces has seen the production of a manual and sets of colour pamphlets to assist extension workers with disease diagnosis. A number of diagnostic laboratories have been established, giving increased opportunity to interact with district staff and farmers in disease surveys, collaborate in field trials and monitor diseases. Scientists at the Plant Ouarantine Diagnostic Centre in Hanoi are now implementing the findings of an earlier project that developed national phosphine fumigation standards for Vietnam to control insect infestation in stored grains. This work provides essential support to the country's growing export trade, helps to ensure internal food security and underpins effective quarantine protocols. A first step is a national program to train officers from three key phosphine user groups. ACIAR supported six three-day workshops in centres throughout Vietnam that emphasised practical aspects of fumigation but also included information on relevant legislation and development of phosphine resistance and management. Officers are now equipped to implement the changes, which include increased use of safety equipment, better sealing of fumigations, and use of gas concentration monitoring instruments.



Launch of the new protein-bait facility at An Thinh Brewery in Hanoi

Vietnam needs comprehensive information about local fruit fly species in order to develop an export trade in fresh fruits and certain vegetables. Also, in northwestern Vietnam new plantings of temperate and subtropical fruits, established for development of poor areas, are suffering close to 100 per cent fruit fly damage. Farmers have become disillusioned and will abandon the development schemes unless solutions are found quickly. A project is ascertaining the economically important species of fruit fly and the host fruits of every species identified. It is also measuring damage levels of the major species and their seasonality, and is introducing environmentally friendly, preharvest control by bait-spraying. There are now two factories in Vietnam producing protein bait, one in the north and one in the south, and there is progress in producing bait 'sticker' as an efficient means of placing the attractant and a minute amount of insecticide on trees.

In collaboration with the Vietnam Women's Union, a new project was commenced on the production and **utilisation of indigenous vegetables** by women in Vietnam – designed to specifically target the safe production, promotion and utilisation of indigenous vegetables and the role of women in these



Hanoi is the major market for agricultural produce from the north-west regions of Vietnam

activities. A scoping study that investigated potential vegetables laid the foundation for the four-year project. Commencing in Pho Tho province in the north, local women's groups have been formed and are now sharing knowledge of local vegetables and planning which vegetables to develop.

C: Competitive and sustainable aquaculture and livestock production

In aquaculture and mariculture, small-scale aquaculture of freshwater species in the Mekong delta is a potentially important source of income, but is constrained by costs associated with feed and feeding. An ACIAR project is developing diets based on locally available ingredients for improved production of catfish and tilapia for the two countries (Vietnam and Cambodia), and also studied nutritional requirements of barramundi in Australia. Scientists have used growth and metabolic models to determine nutritional needs at different water temperatures. This information has been vital in formulating diets for the three species. In March 2008 a two-day extension workshop on fish nutrition and feed management was held at the Phu Tao Field Station in Hai Duong. The program included a half-day field trip to tilapia farms to view feed manufacture and feeding practices.



Reservoir fishery development and management

Market demand for lobster is rising throughout much of the world, despite lobster fisheries being fished at either maximum capacity or being in decline. A project seeks to lift lobster aquaculture in Vietnam through assessing the ecological impact of collecting seed lobsters, reducing post-capture losses, and developing best practice husbandry for grow-out. Study of seed lobsters for the most sought-after species, Panulirus ornatus, revealed that the harvest of seed was only half that of the previous season. This has been compounded by severe lobster disease problems, which are leading farmers to choose finfish culture ahead of lobster. Efforts to encourage lobster culture have also centred on the role of transport and nursery cage practices on the growth and survival of seed lobsters. Researchers have found that, within the bounds of current commercial practices, stocking density and initial land-based holding time had only slight effects on subsequent growth and survival of the lobsters. However, increasing transport time had a profound adverse effect on survival rate, which often was apparent only after 30 days of nursery culture. Researchers are looking for improved transport methods that reduce the stress on the lobsters.

Work has also been undertaken to develop improved and less-polluting methods for **seacage grow-out of lobsters.** Early results indicated that lobsters fed trash fish with mussels grew and survived better than those fed only trash fish. But it was found that the inclusion of soybean meal in the diet brought about an almost linear decline in lobster growth rate. Culturing mussels alongside the lobster cages improved the environmental conditions adjacent to the cages, and widespread adoption of this practice could help ameliorate the poor water quality in Van Phong Bay.

Sustainable income generation for smallholder farmers in the central provinces is a major development issue. The Quang Ngai Rural Development Program determined that cattle rearing and, in particular, finishing were the most desired income-generating activities for households, but farmers and extension staff had insufficient knowledge about cattle nutrition and production. An ACIAR project developed inventories of feeds available in Quang Ngai and a database of their nutritive characteristics, then provided local supplementary feeding response data to help predict live weight gain from a range of feeding options and to estimate likely profitability. Researchers recommended further research to reduce the amount of protein in formulated concentrates as a way to contain feed costs. Participatory on-farm research activities confirmed that the concentrate feeding options were suitable for rural households and were more profitable than existing feeding systems, and the farmers accepted them well.

With pig production in Vietnam such an important industry for smallholder farmers, who supply 80 per cent of all pigs, the longterm viability of production is threatened by the high cost of feeds. A key ACIAR livestock program is addressing the rising commercial, imported feeds for pigs by researching the use of local ingredients in pig feeds. While the use of cheaper local feedstuffs was indentified as a viable solution, it was limited by a lack of knowledge of their suitability for pigs. This project aims to bridge the gap by assessing locally available protein and energy sources as potential components of commercial pig diets. Detailed chemical analysis and on-station digestibility and feeding studies have been conducted for a number of local feeds. Four feeds are being initially studied—rubber seed meal, sesame seed and cottonseed meals to replace imports of soy meal, and cassava as a potential replacement for imported corn. As each contains anti-nutrient factors that reduce nutrient intake, these factors are also being examined to determine how to reduce them to acceptable levels. It is anticipated that performance testing and on-farm assessment will follow the laboratory analysis work undertaken to date.

Subprogram 2: Optimising water and soil management for sustainable production, particularly on degraded lands in central Vietnam

Central coastal Vietnam is the driest part of the country with most of the rain falling in only three to four months of the year. A project aims to increase the efficiency of using scarce irrigation water and improve soil management in horticultural tree crops in the central coast provinces. A survey of farmer practices conducted in Ninh Thuan and Binh Dinh provinces has questioned 300 farmers about their farming system, water use and fertiliser use. In March 2008 a consultation workshop involving 50 Vietnamese stakeholders and several ACIAR staff commenced the design of a new program to identify cost-effective and sustainable crop cultivation and livestock production systems for the infertile, sandy soils of the



Harvesting an intensive herb and vegetable production systrem



Young Hmong girls near Sapa earn money by selling handicrafts to tourists.

south central region. This region and the north-western highlands are becoming the high priority areas for ACIAR's program in Vietnam.

Development of a decision support framework is allowing basic soil information to be interpreted in terms of soil constraints to productivity and to be synthesised into management strategies appropriate for maintaining the long-term productivity of upland soils. Results obtained in a site-specific context can then be applied at a provincial/ catchment scale. The scientists are applying geo-coded soil survey data and a simple Soil Constraints and Management Package (SCAMP) in making better informed decisions about sustainable soil management. So far they have used SCAMP to process the information from a soils map at 1:100,000 scale for Gia Lai Province. As well, the SCAMP manual and supporting resource materials have been translated into Vietnamese. SCAMP courses are teaching provincial and district extensionists and project staff and leaders of World Vision agricultural development projects how to apply the package themselves.

Agricultural R&D has not traditionally connected with Vietnam's rural development programs. Work is now under way to train selected Vietnamese R&D practitioners in how to tailor research and development agendasetting and output to suit **the needs of ethnic minority communities** in the Central Highlands with a focus on crop protection. So far, researchers have conducted a needs and opportunity assessment study that included interviews with leaders and members of seven ethnic minority communities in Dak Lak and Gia Lai provinces, together with a survey among staff and managers of research and extension institutes, five in the Central Highlands and one in Hanoi. This work established a good basis for the research method in a more extensive project in the North West. This second study conducted in Yen Bai, Lai Chau and Lao Cai provinces identified and trained local survey teams and then carried out more extensive farmer group surveys and interviews with district and province officials. A final workshop in June 2008 culminated in the analysis of survey results and discussions with a range of stakeholders on research needs and opportunities principally for ethnic minority farmers in this area. The results in this study will be a key part of the information to the development of ACIAR's research program in the north west.

Since the 1980s there has been a focus in Vietnam on **more efficient nutrient use in rice production**. Success has been achieved using inoculant biofertilisers, and the plant growth-promoting rhizobacteria (PGPR) have been shown to promote the nutrientefficient growth of cereal crops. Preliminary research funded by ACIAR and AusAID verified in field trials near Hanoi that the PGPR effect



Long-term development of Vietnamese agriculture depends of the efficient and effective use of land

The 'guava effect': a new tool in the fight against citrus greening

Huanglongbing, or citrus greening, is a disease spread by the Asiatic citrus psyllid. Despite the use of pesticides, the disease has prevented the establishment of viable citrus industries in parts of Asia, seriously affecting the welfare of farmers and national economies. It is also a threat to biodiversity through the loss of citrus species and citrus relatives that are endemic to the region.

Huanglongbing and the citrus psyllid do not occur in Australia, but there is a high risk that they could be introduced by natural and unintentional human-assisted spread through Indonesia and Papua New Guinea on known and possibly alternative hosts. While recognising that complete control is not possible, there is merit in gaining better understanding of the psyllid vector in order to minimise populations and reduce disease transmission, and to optimise the role of natural enemies to the psyllid within sustainable integrated crop management programs. In southern Vietnam, project scientists have tested the application of mineral oils, pesticides and other management strategies.

An exciting development involves the interplanting of guava among citrus trees, a practice first identified by Vietnamese citrus growers. The guava plants appear to contain an aromatic compound that repels the psyllid. The incidence of greening was markedly reduced in trials of mixed guava and citrus. And the scientists confirmed that the disease had not appeared for 15 years in some small Vietnamese groves growing citrus and guava together. The impact of guava interplanting on the spread of the disease has the potential to increase the economics of citrus production in the Mekong Delta and similar environments through dramatic reductions in pesticide use and increased longevity of citrus orchards and income from the sale of citrus fruit. The effect of guava interplants on the spread of the disease has gained worldwide attention. Huonglongbing has taken hold in Florida and is starting to markedly affect production in the citrus industry. Researchers there have investigated many avenues for possible means of combating the disease.

A plant pathologist from the U.S. Horticultural Research Lab in Florida learnt about the 'guava effect' from ACIAR project researchers. The meeting led to a visit to the site in Vietnam by a delegation of Florida citrus researchers. They were impressed by what they saw. Now the research lab is jump-starting research by buying 15,000 to 20,000 guava trees to learn more about how the guava might suppress the psyllids that spread greening. They have committed US\$10 million towards research into the disease.

One aspect of the study was that Vietnamese growers divided their groves half and half between citrus and guava trees, which would be unfeasible economically in Florida and in developing countries with large citrus industries. The U.S. researchers will focus on the naturally occurring volatile compounds in guava that confuse or repel the psyllids. If they can isolate the compound and prove its effectiveness against the psyllid, it would then be possible to synthesise it for application as a spray or pellet in a citrus grove. A successful product would also benefit citrus growers in Asia.



Transplanting of rice, the major food staple crop produced by Vietnam

can reliably increase the average yield of rice by 10–20 per cent. A biofertiliser product, now registered as *Biogro*, has been developed, and project work is now extending to farmer trials of biofertiliser technology in the Mekong Delta region. Farmers have reported improved quality of rice with brighter grain, reduced lodging and less need for chemical pest control as well as more efficient use of nitrogen, phosphorus and potassium.

Well grown eucalypts provide high value wood for use in construction joinery and furniture. Poor yields result from growth stresses released upon sawing that cause distortion and splitting in logs, so eucalypts in many developing countries are mainly used for fuelwood, pulp and poles. Two projects are focusing ways to reduce losses: one through genetic and silvicultural controls, the other through better sawing methods. The first project has completed several major wood quality assessments in key trials in all partner countries (China, Vietnam and Australia). Silvicultural and genetic trials of selected Eucalyptus species have been assessed for a range of wood properties and a range of non-destructive assessment techniques evaluated. In Vietnam the eucalypts assessed were progeny trials of Eucalyptus urophylla and Eucalyptus pellita.

With the majority of the large wood quality assessments now complete, the project is moving into a phase of analysis, modelling and evaluation of the economics of the results, working in close collaboration with the team studying **better sawing methods** in the three countries. In the latter project, a processing trial is currently under development for thinned 11-year-old *E. urophylla* at Ba Vi in northern Vietnam. The trial is being conducted at the Pisico sawmill at Quy Nhon in central Vietnam, using standard sawing patterns for teak and a modified cutting pattern to assess the potential to reduce board-end splitting.

The choice of **Meliaceae species such as mahogany**, *Chukrasia*, **and red cedar**, *Toona ciliata*, in South-East Asia and Australia is based on the high-value wood they produce. A barrier to plantation development has been infestations of the *Hypsipyla* genus of insects shoot borers that cause deformation that lowers the quality of harvested logs. Previous ACIAR-supported research has advanced domestication prospects and identified *hypsipyla*-resistant families and provenances. Current research will identify, develop and test tolerant *Toona ciliata* and *Chukrasia*, and improve silvicultural and management protocols to mitigate attacks.

The Philippines

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AOP budgeted expenditure in 2007–08	\$4,250,505	lo, anage
Actual expenditure in 2007–08	\$4,048,844	lonrac try Mc
Expenditure in 2006–07	\$3,476,268	cilia H Coun Dines
Expenditure in 2005–06	\$3,075,454	Ms Ce ACIAR Philip

Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007-08
New project investments aiming to increase income generation from aquaculture designed and implemented	A program of new projects has been implemented covering marine shellfish culture (important source of income for poor fishing families in coastal areas), sea ranching and restocking of sea cucumbers, and the potential for backyard hatcheries to profitably produce marine finfish fingerlings to meet emerging strong demand from farmers. All have a strong livelihood, income-generation focus.
Scoping study on critical policy/regulatory constraints to technology adoption completed and published	Report has been finalised and published and two follow-up activities developed as part of the new horticulture agribusiness program.
Strategy for future investment in community- based resource management/agribusiness programs developed and implemented	Strategy for agribusiness investments in the agreed sectors of horticulture and aquaculture/ mariculture developed and agreed with Philippines counterparts and a major horticulture program designed and implemented. Limited budget resources led to uncertainty about the scope of future community natural resource management (NRM) programs, so this strategy development was deferred.
At least two major vegetable supply chains analysed and improvements identified and communicated	A number of southern Philippines vegetable supply chains were analysed including tomatoes, brassicas and leafy vegetables. Potential improvements to these chains were communicated to a range of stakeholders including a major NGO and a growers' co-operative. The results of this work have also now been incorporated into the major new Vegetable Value Chains program.
40 per cent of new projects to have significant farmer or policymaker impacts within five years of completion	The two major programs (fruit and vegetable agribusiness) developed during 2007–08 are designed to have significant economic impacts within five years of completion.

Position

The main aim of ACIAR's program in 2007–08 was to assist the Philippines to increase the productivity, marketability and international competitiveness for Philippine agricultural products, taking into account the impacts of trade liberalisation. A significant proportion of the Philippines' farming is carried out in fragile sloping environments or sensitive watersheds, and the program recognised that it is important that intensification of agricultural productivity does not come at the expense of degradation.

In 2007–08 ACIAR's Philippines program increasingly emphasised involvement of local partners such as local government units, non-government organisations and farmer community groups in order to increase prospects for sustainable adoption of the results of research. Through the Community Agricultural Technologies Project and other activities, an enhanced effort was made to improve the implementation of results of earlier ACIAR-supported research in the Philippines. Linkages of regionally based delivery organisations with research organisations and policymakers based centrally in Manila and Los Baños were fostered. There was greater emphasis on the southern Philippines in the program in keeping with the directions of the broader Australian aid program.



Australian Ambassador to the Philippines Rod Smith (right) and Dr Patricio Faylon (left) of the Philippine Council for Agriculture, Forestry and Natural Resources and Development signing the Memorandum of Subsidiary Arrangement.

Achievements

Subprogram 1: Increasing the market competitiveness of the Philippines' agricultural products

A: Better systems and policies for meeting market specifications

The El Niño Southern Oscillation event of 2006–07 had a significant impact in the Philippines and Australia. Although much is known in the climate science community about the onset and impacts of ENSO events, work was needed to bridge the gap between the knowledge in the scientific community and the application of this knowledge in decision-making. The scientists looked at the use and potential value of seasonal climate forecasts in the following case studies: corn farm-level studies in Leyte, Isabela and Bohol, a rice farm and household level study in Nueva Ecija, and a general rice policy case study in the Philippines. Other studies took place in Australia. From these case studies the researchers have started to draw together information on the potential value of seasonal climate forecasts. They are encouraged that a number of communication tools and frameworks developed in the project are already in use by groups in the Philippines and Australia.

A project to improve the economic efficiency and policy environment of the Philippines Tree Nursery Sector has examined respective roles and effectiveness of the private and public sector in the tree nursery sector. A policy assessment model has been developed to identify appropriate intervention points for the nursery sector at both the local and national levels. An economic evaluation of the private sector nurseries has commenced. Training nursery operators to enhance their skills in seedling production and improve their knowledge about the importance of seedling quality is underway. A Memorandum of Agreement on the regulation of seed quality has been signed with four collaborating pilot municipalities in Leyte. The work has been reinforced with the drafting of the nursery



Dr Delia Catacutan training farmers in soil conservation as part of the Landcare program

accreditation and certification procedure with certified nurseries expected to attract more sales and higher prices.

As higher temperatures associated with climate change affect rice quality around the world, researchers in the Philippines are developing DNA markers to produce more heat-tolerant varieties and stop rice grain turning to 'chalk', a defect resulting in rice breaking or powdering during milling. With rice the dominant staple in Asia and accounting for more than 40 per cent of the calorie consumption of most Asians, quality and yield losses to rice growers is a major food security issue. With a rise of just 2°C sufficient to trigger the trait, researchers noted a 4°C increase could ruin entire crops. A team at the International Rice Research Institute has redefined chalk's underlying causes and is using ACIAR funds to map newly discovered genetic variation for chalk traits onto discrete regions of the rice genome. The DNA marker can then be developed to facilitate selective breeding efforts that could deliver rice varieties less prone to chalk at high temperature.

B: Higher returns from horticultural products

The Philippines is the world's sixth largest mango-producing country, and its industry relies on **maintaining access to export markets**. However, developed economies are increasingly introducing more stringent standards for domestic consumption, and there is a greater focus on compliance with pesticide maximum residue limits (MRLs) set by each country and at the international level by the Codex Committee on Pesticide Residues. Since MRLs can vary between countries, compliance in the exporting country does not guarantee international compliance, and such disparities can result in inadvertent breaches that could lead to



Weaknesses in supply chains for temperate vegetables limit income generation

loss of market access. A study designed to benefit the Philippines' export industries has analysed the country's mango export chain to learn how current practices may be constraining effective residue risk management. It has also determined the capacity of the local industry to respond to the challenges of increasing scrutiny and regulatory change, outlined a potential framework to meet these challenges, and identified avenues of future research.

A project to improve **strategies for managing postharvest fungal diseases** of subtropical and tropical fruits studied how plant defence mechanisms inhibit extensive invasion of fungi during fruit development. Researchers tested treatments and worked with farmers to enhance resistance and thus suppress disease development on mangoes during



Examining durian fruit quality in Southern Mindanao

production and marketing. The team tested activators that were known resistance-inducing agents, including acibenzolar-S-methyl (Bion®) and elicitors derived from fungal pathogens (in banana). In field trials, Bion® was a consistently effective activator of resistance to anthracnose disease, when applied as a foliar spray or as a soil drench three to five times throughout the fruiting period. There is clearly potential for reducing the number of fungicides applied in a given season if Bion® is applied. Some information is available immediately to industry and has been communicated via workshops and field days.

C: Competitive and sustainable aquaculture production

A 19-day **aguaculture workshop** taught participants the principles of induced spawning of grouper using hormones. They also had the opportunity to carry out handson practices. The groupers spawned and although the fertilisation rate was lower than normal, participants still collected eggs and observed the development. Work on the grouper was augmented with milkfish eggs, from which they learned how to differentiate good eggs from bad and calculate fertilisation and hatching rates. They also carried out live food production from starter to mass production of live feeds, studied nursery management of grouper, and visited sites to observe occurrence of diseases in ponds and the workings of several multispecies hatcheries. In addition to this hands-on knowledge and experience, the participants gained knowledge of marine finfish aquaculture in the region through presentations by technical experts from Indonesia, Thailand and the Network of Aquaculture Centres in the Asia-Pacific region.

A study of **integrated fisheries resource management** in the Rinconada Lakes has been hampered by a sequence of significant natural disasters, the latest being floods that lasted for 30 days in February–March 2008. As a consequence the project objectives and scheduling of work tasks have been reassessed twice. Project work continues in stocking density trials and feeding experiments (including plankton sampling as an indicator of natural 'wild' food availability). Tests of water quality determined that it deteriorated significantly in Lakes Buhi and Bato during the summer months, with low levels of dissolved oxygen in surface and bottom waters the most likely cause of observed fish kills. Substantial progress was made on the water hyacinth composting objective with the design of a hyacinth chopper and conveyor system. However, the location and timing of the water hyacinth composting trials is being reviewed following the flushing of water hyacinth from the lakes by flooding in March 2008.

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

Work on groundwater management has focused on two pilot sites within neighbouring municipalities of Ilocos Norte province, on the north-western tip of Luzon. At these two sites, work involves construction and calibration of groundwater models and scenario testing using these models. A techno-demo farm on water management aspects for garlic production has been established at both sites, and farmer-cooperators have learnt how to monitor soil moisture in the root zone during the cropping period. They recorded soil tensiometer readings on a daily basis, and static and pump water levels at every irrigation application. In the modelling exercise, the scenarios they simulated include the possibility of increasing the areas for garlic production during dry season cropping—assuming the current level of recharge in both basins continues. The possible effect of reduced rainfall due to drought and/or a dry spell (usually associated with El Niño phenomenon) was also studied. In the process, the number of wells and the possible expansion areas were determined so that future groundwater extraction will not exceed the rate of recharge. In a project to **minimise agricultural pollution and thus enhance water quality**

in Laguna de Bay (as well as in the Mt Lofty Ranges in Australia) the team has installed auto-samplers and water loggers to monitor quality at different sites. Philippines staff members have been trained to operate auto-samplers, including their re-setting, maintenance and trouble-shooting, and also to download data from the water level loggers. This has led to training for volunteers to collect and store the water samples prior to processing in the laboratory. Problems encountered include high levels of suspended sediment from upstream bridge construction, pesticides and phosphates (possibly arising from detergents where residents wash their laundry in the river) and piggery waste. The effect of selected pesticides on the growth of duckweed was evaluated across a range of concentrations.



Weeding rice terraces in the upper Inabanga watershed

Better herbicide use strategies and weed management options are needed in both the Philippines' and Australian cropping. A project has worked directly with more than 40 farmer cooperators to deliver new weed and crop management practices that have significantly improved farm production and farmer returns in the short term. Adoption of the practices has been high among this group and there are encouraging signs of farmer-to-farmer transfer resulting in further adoption. The project has delivered significant outcomes for all partners: Australians have had the opportunity to study mechanisms of herbicide resistance, while PhilRice capacity in herbicide use and weed management is now stronger.

The community agricultural technology program continues to **familiarise farming communities with ACIAR-generated and new technologies** and assist Philippines researchers to work with NGOs and community-based organisations. Eight groups are active across a range of project activities including cattle and pig fattening and forage management, goat health management, mud crab and grouper aquaculture. A large range of changes in farmers' production/management practices have been made as a result of the program and a key achievement has been the empowerment of the local community to take up new technologies and generate ideas to apply the technologies to solve agricultural production problems and increase their income. The Program has close links with the successful Landcare project which brings together groups of farmers, villagers and extension specialists and provides them with the training and tools to help them manage their farms and some of the problems threatening the health of their land.

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

The **Landcare project** has now been extended a further two years with AusAID cofunding. The focus has broadened into three regions: northern Mindanao, southern Mindanao and the Visayas, with an enhanced commercial and economic growth focus. Project partners are strengthening the Landcare Foundation Philippines Inc. to become the institution to provide in-country leadership and coordinate future growth and sustainability of Landcare, which continues to gain farmer participation across the country and more connections with NGOs. The Landcare



Principal of Malamba Elementary School with Landcare students

New deal for fruit and vegetable research in the Philippines

In developing agribusiness, the Philippine Government and ACIAR have agreed to focus on the aquaculture/mariculture and horticulture sectors. The horticultural initiatives for high-value fruit and vegetable production that provide higher economic returns per unit area and that develop new export markets were designed and commenced during 2007–08. Rural areas in Leyte, Northern Mindanao (Cagayan de Oro) and Southern Mindanao (Davao) have significant potential for expanding fruit and vegetable production and quality, which could help improve the living standard of the people.

Barriers to achieving these objectives include a lack of grower expertise in soil management and crop agronomy, a high incidence of pests and diseases, under-developed markets and value chains for horticultural produce, and political/economic constraints such as limited capital/resources and insecurity of land tenure. These considerations are behind the recent development of two large multi-disciplinary ACIAR projects: 'Enhanced profitability of selected vegetable value chains in the southern Philippines' and 'Improved domestic profitability and export competitiveness of selected fruit value chains in the southern Philippines and Australia'.

The goal of the first project is to help lift the incomes and improve the livelihoods of growers of high-value vegetables in the southern Philippines. The program focuses on smallholder and industry profitability and market competitiveness of the southern Philippines selected vegetable industries, including potato, tomato, brassica and leafy vegetables. The research team is developing and promoting best management practices for local conditions, thus helping farmers in high-rainfall areas to produce highvalue crops in the wet season when prices are high. Their work builds on foundations laid in earlier projects to tackle bacterial wilt in potatoes and tomatoes, to assess the institutional market for high-quality vegetables, improve the capacity of smallholder farmers to access these markets, and design interventions to improve the performance of value chains.

The goal of the second project is to lift economic growth in the Philippines through increased income and improved livelihoods of tropical fruit growers in the southern Philippines, targeting mango, papaya, durian and jackfruit. The research group is identifying constraints to papaya supply chains in the Philippines and determining how growers could gain increased value from the supply chains to which they belong. It also seeks to lift productivity of jackfruit in the eastern Visayas and durian in Mindanao.

The team aims to lift productivity of papaya in the southern Philippines and Australia through integrated crop management to control bacterial crown rot and *Phytophthora*-related diseases and major insect pests. Another project component focuses on sustainability of the mango industries in the southern Philippines and Australia by improving pest and disease management and ensuring consistency of supply of quality mangoes for targeted markets.

Both project teams are studying the economic impacts of new technologies and policy constraints in fruit and vegetable production in the southern Philippines and Australia. Their findings will help guide the course of further research, enhance the adoption of technologies and identify policy constraints and options for change.



Dr Thelma Paris, social scientist with IRRI researched the impact of migration and off-farm employment on women

project will profit from cross-linkages with a new large ACIAR project on horticulture value chains.

A project targeting increasing the financial returns to smallholder tree farmers in Leyte in the Philippines has continued work to generate supplementary income via better market access, agroforesty systems and knowledge of prices for smallholders and community forestry practitioners. Researchers have been active in disseminating outputs from the first two years of the project. A School-on-Air radio program on tree farming policies was presented and a CD version subsequently prepared and distributed. Extension materials (including a primer on tree registration) on harvesting approval and log transport, a booklet on tree growing, and a manual on tree nursery establishment were widely distributed. Various training activities were also undertaken, including those involving 80 farmers in Claveria and Misamis Oriental, and the presentation of project-related research outputs were also made in two important national forums: the National Agroforestry Congress and National

Forestry Education Conference. The project team also organised the international 'IUFRO 3.08 Small-scale Forestry conference'.

While seasonal migration off-farm by men is leaving women in charge of farms, Asian social scientists believe the phenomenon is quietly reweaving the social fabric of many rural communities. ACIAR-funded collaborative research efforts are helping providers of agricultural development aid better understand the changes and provide resources, agronomic information and appropriate technologies to women as heads of households and farm managers. Farmers have responded well to efforts on the agricultural fronts with the impact of training women increasing yields by 15–20 per cent in rice-based mixed farming systems in the Philippines. The program scope has extended from the Philippines to the lower Mekong basin with similar productivity improvements. The results of the program have demonstrated the power of social science and gender research to drive farming improvements side by side with more traditional technical R&D programs.

East Timor

AOP budgeted expenditure in 2007–08	\$2,072,061
Actual expenditure in 2007–08	\$2,790,567
Expenditure in 2006–07	\$1,592,108
Expenditure in 2005–06	\$1,909,083

Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
At least four demand-driven small projects commissioned to leading agricultural researchers	Seven projects have been commissioned, addressing farming systems analysis, beef marketing, alley cropping, cattle reproduction, pasture composition, rice and maize seed systems, and socio-cultural aspects of crop production.
On-going success in the implementation of jointly-funded ACIAR–AusAID Seeds of Life 2 program in close partnership with Ministry of Agriculture, Forestry and Fisheries	New high-yielding varieties have a high level of adoption with farming families. Beyond germplasm, the Seeds Of Life 2 program interacts closely with the Ministry of Agriculture Forestry and Fisheries on broader issues including national crop variety and seed legislation.

Position

ACIAR's 2007–08 program in East Timor focused on food security, poverty reduction, and capacity building. The focus is on applied assistance as R&D capacity and infrastructure are being developed. The major program is the 'Seeds of Life 2' program, which is co-funded by AusAID and ACIAR. Projects on Siam weed control and cassava production commenced in 2004–05 and in early 2006 a small R&D projects funding and management facility was established to support focused activities addressing high priorities in agriculture.

Achievements

Seeds of Life 2 (SoL2) activities included **evaluation of new germplasm** and associated technologies. All five CGIAR centres collaborating with SoL (CIAT, IRRI, CIMMYT, ICRISAT, CIP) have provided well-adapted breeding lines and varieties of maize, cassava, sweet potato, rice, peanut and pigeon pea for evaluation between 2006 and 2008. Replicated variety trials for maize, peanuts, sweet potato, and cassava were installed at four sites together with rice at two sites (a total of 18 replicated trials). Collection of local varieties of the main food crops commenced after a two-week training course on germplasm collection in April 2008.



Fatumaca Station workers with improved maize stock.

It is expected that at least 100 varieties each of rice and peanuts will be collected at the end of the growing season.

Up to 80 per cent of the population remains dependent on agriculture but limited capacity is hampering ongoing development. Boosting both production and capacity in East Timor, however, is difficult, as it needs to be undertaken on a small scale. A project is attempting this by investing in small projects that link East Timorese researchers with local agricultural producers. Australian experts are acting as mentors, providing research and project management knowledge and other information to support project development and implementation. The first group of projects have proceeded satisfactorily and their outcomes were reported at the third National Agricultural workshop conducted at Hera in November 2007. At that workshop, working groups established research needs and priorities for a second round of projects. The suggested topics were developed into proposals and presented to the Project Steering Committee in March 2008 for funding.

In other work, *Chromolaena odorata*, a **major invasive weed** which is toxic to livestock, has invaded pastures, crop gardens and other areas in East Timor, causing significant livestock losses. Goats, cattle and buffaloes been particularly affected. A project is introducing biological control agents against Chromolaena that have already been successfully introduced in PNG and Indonesia. In the past year the project collaborators have actively progressed the project by releasing Cecidochares connexa (gall fly) at numerous sites throughout the country. In April 2008, galls of C. connexa were observed 21 km along the road from the Baucau Airport site where gall flies were released in March 2005. Field surveys in the enclave district of Oecusse in July 2007 revealed that galls had become established in all four subdistricts of Oecusse by natural spread from West Timor, Indonesia, where gall flies were released approximately 10 years ago. Local communities have already reported stunting and a reduction in health of local stands of chromolaena where C. connexa has become established. Efforts are also continuing against the invasive Mimosa diplotricha. A nursery at Hera has reared large numbers of a psyllid insect which feeds on the mimosa and there has been a wide-scale release of the psyllid into mimosa infestations.



ACIAR's Seeds of Life 1 project team
Cambodia

AOP budgeted expenditure in 2007–08	\$1,636,329
Actual expenditure in 2007–08	\$1,867,363
Expenditure in 2006–07	\$1,744,985
Expenditure in 2005–06	\$1,442,684



Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
Field crop diversification fostered through commencement of trials on suitability of maize and legumes following rice in lowland farming systems and characterisation of marketing systems for these products. Processes that improve profitability for Cambodian farmers and traders assessed and modified.	Maize and soybean systems trialled in NW Cambodia to foster crop diversification and development of effective value chains for associated products from the farmer through to the consumer. Farming practices that improve profitability for Cambodian farmers are being assessed and refined, as are processes involving traders and other stakeholders along the supply chain.
Linkages developed between Cambodian research and extension organisations in ACIAR projects and the new AusAID Cambodian Agriculture Value Chain Program (CAVAC), and strategies for the institutionalisation and continuation of CARF assessed	Design of new CAVAC program involves integration of research and extension and also provides for continuation of Cambodian Agricultural Research Fund (CARF) for a further five years, with options for institutionalisation to be explored.
Initial analysis of transboundary livestock disease threats completed	Analysis ongoing through a risk assessment project and first analysis completed through a project delivering deeper and broader understanding of the issues relating to national and regional livestock movements.
Contribution to better vegetable production systems in Cambodia through evidence of farmer adoption of improved tomato and chilli varieties	Work on the vegetable production and postharvest management systems shifted its focus to extension activities and to Siem Reap and Kampong Cham. Growers who attended the six field days held in three provinces ordered commercial quantities of superior tomato seed for next season. A case study with a Kandal farmer demonstrated that his net income doubled by using improved tomato varieties and production techniques.
40 per cent of new projects designed to have significant farmer or policymaker impacts within five years of completion	Both the new Cambodia projects designed in 2007–08 (beef cattle production; maize and soybean systems) plan to have significant impacts within five years of completion.

Position

ACIAR's strategy in Cambodia in 2007–08 had two thrusts: firstly to support applied research that underpins agricultural diversification, particularly into non-rice field and horticultural crops and ruminant livestock, and secondly to support research that aims to increase and secure the productivity of rice-based farming systems. Maintaining and increasing rice yields remains critical to improving food security and incomes in Cambodia. Rice security and income from rice enable farmers to invest in higher-value activities such as vegetables, fisheries or livestock. Increasing rice yields can reduce the area under rice cultivation, making more farm land available for higher-value agricultural activities. In 2007–08, the ACIAR program also had a strong emphasis on building Cambodian research capacity and encouraged collaborative linkages between Cambodian organisations.

Achievements

Subprogram 1: Securing productivity of rice-based farming systems

Rice is Cambodia's most important staple crop, occupying 90 per cent of all agricultural land. More than 2 million acres are devoted to the crop. ACIAR's work in Cambodia focuses on diversifying agriculture and improving rice yields. Several diseases—brown spot, rice blast, false smut, bakanae and kernel smut -are the most common. Little information is known about the distribution, prevalence or impacts of these diseases in Cambodia and local plant pathology expertise is very limited. The ACIAR project has improved understanding and management of rice pathogens in Cambodia and has made a significant contribution to the building of Cambodia's long term agricultural research capacity. The project has seen the establishment of the first plant disease herbarium in Cambodia at the Cambodian Agricultural Research and Development Institute (CARDI), enabling the training of Cambodian researchers in basic plant pathology techniques and providing



Researchers and staff work on crop trials at CARDI

on-going reference material for research and in-house training. Surveys of lowland rice crops have also been carried out in Takeo, Kandal, Svay Rieng, Prey Veng and Kampong Chhnang Provinces and crops of upland rice in Ratanakiri and Mondulkiri Provinces that had suffered large losses due to a combination of disease, adverse weather events and insects. Australian plant pathologists have also gained a better understanding of the exotic diseases that have been identified as a threat to the Australian rice industry.

In the first year of another significant project in Cambodia focusing on **crop diversification in rainfed low land rice cropping areas**, researchers have established identical activities in three major lowland rice growing provinces of Kampong Thom, Kampong Cham and Takeo as well as two model farms developed with farmer owners. Work has progressed on developing profitable double cropping systems and the associated



A Cambodian villager harvests rice

water requirements of non-rice crops with the testing of a number of soil types and three legume crops (peanut, soybean, and mungbean) and assessment of the varieties of mungbean and soybean that were available in-country.

Progress has continued in the development of **conservation farming implements** for two-wheeler tractors (power tillers) in Cambodia, Laos and Bangladesh. A power tiller and a rotary tillage seed drill were imported into Australia from Asia for testing in mid 2007. Six power tiller seed drills have been fabricated. Four drills are of the tyne type on a tool bar frame, modelled on the original Asian-built International Maize and Wheat Improvement Center (CIMMYT) power tiller seed drill, while the other two are modifications of a Chinese rotary tillage seed drill, which is now being sold in Asia.

Subprogram 2: Income generation and better nutrition through agricultural diversification

ACIAR has managed the Cambodian Agricultural Research Fund (CARF), initially with AusAID co-funding, since 2002. CARF was established to provide Cambodian scientists with an opportunity to compete for agricultural research funds. It is open to government, university or college and NGO organisations based in Cambodia; all must have the clear ability and mandate to implement research within Cambodia. CARF has delivered a comprehensive training program including the writing of research proposals, problem definition and biometry followed by individual support and coaching for over 100 scientists. As a result of a favourable review in 2006, ACIAR funded further rounds of CARF in 2006-07 and 2007-08.

A priority is to increase **focus on non-rice upland crops** for the purpose of poverty reduction through production for local and export markets. A current project has identified and overcome constraints to the adoption of non-rice upland crops in Cambodia, and developed simple tools that farmers and advisers can use to monitor the performance of their crops and how they fit into the farming system. The project team conducted 153 on-farm experiments and demonstrations that included variety evaluation, attention to insect pests and disease, reduced tillage, and agronomy and farming systems. This work has impacted significantly on the CARDI approach to research in the uplands, and the improved practices identified will be further developed in a follow-up project to improve the functioning of the productionmarketing system for maize and soybean in north-western Cambodia.

A related project aims to increase the range of crops grown under rainfed lowland conditions by promoting non-rice crop technologies that provide **efficient water use and high financial return** to the growers. A project is measuring the available water and examining a range of management



Cambodian women working on a trial farm

options for growing non-rice crops such as peanut, soybean, and mungbean. In 2007–08, the project team tested a number of soil types that are potentially suitable for legume crop production across three provinces. They made key observations on the importance of sowing at optimum time, requirements of furrow and bed planting for some soils, potentially large impacts of insect pests and diseases, and importance of providing sufficient amount of irrigation water to maintain optimum crop growth.

A project to improve **vegetable production and postharvest management systems**

in Cambodia and Australia moved into an extension phase, with an increased number of demonstrations and replicated trial plots established on farms. The project also shifted its focus from Kandal province to other vegetable production regions such as Siem Reap and Kampong Cham. Selections from tomato and chilli trials were grown on 11 separate farms across three provinces, Kandal, Siem Reap and Kampong Cham. District and provincial staff assisted CARDI and Department of Agronomy and Agricultural Land Improvement team members in managing the sites and conducting field days. Farmers participated in assessing the varieties at sites in Siem Reap.

A suite of livestock projects in Cambodia has targeted animal health to support Cambodia's agricultural expansion. Control of one of South-East Asia's most pervasive livestock diseases, fasciolosis, entered a new phase when the project in Cambodia on the development of a model for the **control of** fasciolosis in cattle and buffaloes translated the science into new stock management practices on farm. Following Cambodian researchers involvement in fully establishing the disease's epidemiology, the project moved to the bigger challenges of control and farm management which included a control program for fasciolosis for Cambodia and involvement in the fasciolosis control network in the region and extension material in Khmer. Results from the education and extension work on fasciolosis and control measures show farmers' knowledge and understanding of the disease was greatly enhanced, resulting in increased adoption rate of best practice control options. A newly launched project building on the work to control fasciolosis aims to improve the profitability of cattle and buffalo production by smallholders



Cambodian family with the family's freshly harvested chilli



Disease is a perennial threat to raising valuable livestock in Cambodia

through **adoption of well known disease control and husbandry practices**. The project team will be working at six project sites, consisting of three sets of 'matched' villages, and have the opportunity to compare the effects of introducing a 'best practice' health and production package.

While most farmers in Cambodia keep cattle for draught and wealth accumulation, there is untapped **potential for cattle production** as a source of income. But providing feed for cattle is a major challenge for eight months of the year, and the problem is compounded by labour demands (up to eight hours daily) associated with feeding cattle. A newlylaunched project aims 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. Most importantly it capitalises on the recent introduction of improved forages and fodder banks to Kampong Cham by the International Center for Tropical Agriculture (CIAT) though an earlier project and will apply the successful feed-year management approach developed through another livestock production system project.

Improving feed also plays an important role in **growing small scale aquaculture in Cambodia** as a key source of potential income. The project covering Vietnam and Cambodia has produced a collective 'ingredients for feed' database and identified nutritional requirements for fish species tilapia and catfish. The results showed that the new diet formulations produced fish that grew faster with a more efficient use of feed. These feeds and feeding strategies are now being tested in on-farm feeding trials and will be extended to farms and feed mills. A range of workshops and master classes have been conducted to build capacity among nutrition researchers. The outcomes of the research were also presented at the World Aquaculture Society Conference in Hanoi in August 2007.

Another focus of livestock program work has been funding for biosecurity projects. One project covering **best practice control of diseases in cattle** is working on project sites established where farmers want to develop large ruminant production and is designing and implementing a survey of trader knowledge and attitudes to improving cattle marketing. Another project tackling risk assessment for **transboundary diseases** has worked with livestock traders' networks to define the traders' networks and analyse movement patterns and ultimately enhance livestock management practices and enable researchers to quickly pinpoint high-risk areas.



Improving the nutritional value of feed is key to the growing small scale aquaculture in Cambodia

Lao PDR

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AOP budgeted expenditure in 2007-08	\$1,517,868	unpai
Actual expenditure in 2007–08	\$1,626,328	orn S
Expenditure in 2006–07	\$1,207,853	Chirat
Expenditure in 2005–06	\$963,473	Khun



Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
Validation of community extension processes in two provinces of northern Lao PDR	A past project introduced poor farmers to forage and livestock technologies and approaches that accelerated animal growth, while minimising the reliance on shifting cultivation. The success of these technologies, in concert with extension methods that enhanced farmer learning, resulted in the number of participating farmers doubling within two years. A new project fostered further adoption of improved livestock production across five provinces.
New forestry program in Lao implemented, addressing value-addition through processing and improved agroforestry systems	Project cluster designed and implemented that aims to improve silvicultural management and use agroforestry systems combining teak with non-timber forest product species; it will also expand Lao timber processing and manufacturing so more value-adding can be carried out and the returns captured locally.
Major project on diversification of lowland rice-based cropping systems implemented in three provinces	Project implemented on crop diversification and successful on-farm trials initiated in provinces of Vientiane, Savannakhet and Champasak
New forestry program in Lao implemented, addressing value-addition through processing and improved agroforestry systems	Forestry project aimed at improving the Lao timber processing industry is making good progress and another to develop teak-paper mulberry agroforestry systems in northern Laos is about to commence.

Position

The 2007–08 year was a period of growth for ACIAR's program in Lao PDR. It emphasised crop, livestock, fisheries and forestry research to develop viable alternatives to shifting cultivation in the uplands through better crop and forest production and livestock health and production. It also has a focus on agricultural diversification to improve productivity of lowland farming systems. All of the project activities had a strong emphasis on capacity development, and a number of the research interventions were designed to complement larger donor programs on improving rice production, forestry and animal health and production.

Achievements

Subprogram 1: Alternatives to shifting cultivation in upland regions

ACIAR's livestock program form the largest part of the Lao Program and a suite of animal health projects have delivered solid returns. In northern Laos research undertaken in a CIAT project revealed that pigs could benefit from the addition of stylo forage to their diets. This has led to an ACIAR-funded project also involving CIAT which is evaluating bestbet legumes for their feeding value to pigs. The researchers found that while some local feeds were high in much needed protein, supplies fell short of needs, so growing stylo (Stylosanthes quianensis) helped to overcome this. On the traditional diet pigs took 10 months to reach marketable size, but if a few handfuls of fresh stylo were fed each day then pigs were ready for market in six months. It also took far less time to gather the stylo leaves than search the forest for greenery, so the women farmers had more time to tend their rice fields. The positive experience with stylo has paved the way for further work introducing legumes and helping spread the practice more widely.

So far the project is working with 440 farmers from 30 villages in two provinces in Northern Laos, through collaboration with nine NGOs and three district extension services, the work on forage legumes is reaching about 1,200 famers.

Village-raised pigs add substantially to the income of Lao farmers, but pig production is under pressure from the endemic presence of infectious diseases – especially **classical** swine fever (CSF) and foot-and-mouthdisease. ACIAR-funded research has enabled Australian and Lao scientists to work together to develop methods to detect the diseases and manage them at the village level. Project scientists are working to validate a particular type of ELISA test, whereby antibodies are attached to magnetic beads rather than plastic trays. The test known as IMB-ELISA is an ideal candidate for the diagnostic needs of smallholders in Laos. It is already available at four provincial laboratories where a preliminary diagnosis is possible within 35 minutes of receiving a sample. This is a vital adjunct to the mainstream CSF diagnosis nationally and regionally. The project is also developing and implementing a program of CSF vaccination as a control strategy in



A Lao farmer cuts stylo for the family's pigs



Family pigs in Laos

village production systems and working to maintain a diagnostic capability for FMD by providing appropriate FMD reagents.

Work on important **pig-associated zoonoses** begun in early 2008 represents a significant change in direction by recognising a range of diseases that can be transmitted from pigs to people and investigating their importance in Laos in partnership with human health investigators. The project will establish



Lao farmer keen to expand his livestock production and set aside land for planting fodder crops

prevalence, distribution and socioeconomic impacts of a broad range of medically important pig-associated zoonoses to determine the risks associated with human and pig transmission in villages and identify practical control strategies. Together with local health and agriculture agencies the project will test the effectiveness and adoption of control measures. This is the first project of this type in the region and results, including lessons learned from the animal-human health researcher collaboration, are expected to be widely reported.

Cattle and buffalo also play an important part of agricultural systems in Lao PDR, accounting for approximately 20 per cent of agricultural GDP. Ninety five per cent of the two million cattle and buffalo in Lao PDR are owned by rural households that farm on a subsistence basis, providing draught power, nutrition and cash income. However, diseases, poor feeds and subsistence-based husbandry practices limit the smallholders' ability to service the demand for livestock meat across Asia. An ACIAR project has addressed cattle health system constraints by examining current practices and knowledge of livestock diseases and husbandry, including through farmer participation and other ACIAR projects on disease control in the Mekong, to deliver a best practice approach to improve livestock productivity, potentially increasing marketing opportunities for smallholder livestock producers.

A scoping study to identify **research priorities for the development of the beef industry** in Cambodia and Lao PDR with special reference to animal health interventions was undertaken. The study determined there is an increased demand for health and other interventions as well as risk management to improve production and protect increased investments in livestock, particularly with scaling out forage technologies. There is also a role for ACIAR in meeting the need. The study also found there was the necessary capacity to deliver the project in both Laos and Cambodia. Finally, famer attitude surveys across three key provinces in each country found a high level of interest in participating in an applied research program to support an emerging beef industry.

Pressure is not only on livestock production to meet increasing demand but also on fish production which is almost entirely based on the seasonal riverine and reservoir capture fisheries. An aquaculture-based fisheries development project is being positioned to close the gap between supply and demand. With the industry is still in its infancy, the project has targeted development technological packages that can, with village community participation, optimise yields from culture-based fisheries (CBF) practices in flood plain depressions and reservoir coves in two provinces of Lao PDR. The first farmer CBF trial has been conducted and propagation work begun for the two selected indigenous fish species as well on the development of a broodstock management plan for these two species. Work is underway for the second trial to be conducted during the forthcoming spawning season.

Plantations of eucalypts and teak are grown in parts of Laos. Some of this timber is processed locally for furniture manufacture but most is exported to Vietnam and Thailand. Opportunities exist to expand Lao timber processing and manufacturing so 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 application of quality controls. So far work has involved the formation of a network of nine furniture companies and one sawmill by the Project Steering Committee who selected partners according to strict criteria that included use of plantation timbers and sustainable production. An assessment of the current capabilities of the companies involved in this industry cluster has formed the basis for development of future directions in processing, drying and manufacturing.



Dr Russell Haines (ACIAR) and the forestry project team observe current silvicultural practices in Luang Prabang, Lao PDR

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

A four-year project has commenced in Laos 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 first objective is to use an on-farm, farmer participatory approach, to select and test the best rice cultivars from breeding pools in the Lao improvement program. For the period 2007–08 farmers from the three lowland provinces Vientiane, Savannakhet and Champasak each selected three promising lines from among 20 rice varieties to grow on their farms during the 2007 wet season. The 41 farmers who successfully completed the trial will receive seeds of their favourite varieties for further testing in the 2008 wet season. The project is also encouraging Lao smallholder farmers to evaluate direct seeding options for rice.

An ACIAR–World Vision collaborative project has had a focus on improving crop yields in rainfed-based systems in the central lowland of Laos. The project has trained and mobilised district extension workers to form famer groups involving 160 farmers in more then 30 villages and to support them in undertaking on-farm variety/fertiliser trials. The trials have been successful in



Trained extension workers collaborate with farmers to improve crop yields

demonstrating the yield advantage of improved varieties and improved fertiliser practice. The established farmer groups have proceeded to identify further improvements in crop management, and the work will be expanded to include more villages. The partnership between ACIAR as a technology provider and World Vision as an NGO with strong community contact proved to be a real advantage when it came to introducing new practices.

Approximately 90 per cent of funding support for agricultural research in Laos is coming from sources external to the country. Most of this funding is for large agricultural projects, many of which have specific development objectives and are often undertaken on a collaborative institutionto-institution basis. Lao scientists have little opportunity to access research funds for smaller programs of development consistent with the national agricultural research and development guidelines for the country. The Lao Agricultural Research Fund (LARF) was established to provide Lao scientists with an opportunity to access, and compete for, funds for agricultural research. The project will allow the research groups to secure research funding, be a capacity builder and help build linkages between research and extension and NGOs.



Facilitating farmer to farmer learning in a Lao village

Thailand

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AOP budgeted expenditure in 2007-08	\$620,449	nnpa
Actual expenditure in 2007–08	\$558,710	orn S
Expenditure in 2006–07	\$542,659	Chirat
Expenditure in 2005–06	\$616,955	Khun



Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
New collaborative project developed with an NGO to enhance adoption of results of earlier ACIAR-funded research	Project designed and implemented with World Vision in NE Thailand to enhance adoption of earlier ACIAR-funded rice production and livestock forages work.
At least one new project developed on the basis of co-investment from Thai institutes and/or regional agricultural consortia	Significant co-investment from Thai partners in three projects
New linkages between Thai and Lao partners in two ACIAR projects	New linkages in two projects (animal vaccine manufacture, fish passage development) add to those established in 2007–08 in rice-based cropping systems and in culture fisheries.
New collaborative biosecurity research program established in conjunction with relevant Thailand and Australian agencies	Biosecurity project (CP/2006/170) designed in 2007 and implemented in early 2008. Training workshop on molecular diagnostics for Thai scientists held in Australia.

Position

In 2007–08 ACIAR's Thailand program focussed on two issues: implementation of the results of earlier projects, with relevance to the poorest farming communities; and enhanced scientific and policy exchanges on biosecurity research and systems implementation. ACIAR worked closely with Thailand partners to obtain joint funding on agreed projects, and a number of opportunities for partnering with Thailand were pursued with respect to Laos.

Achievements

Activities in Thailand during 2007–08 centred round the development of new projects that advanced the uptake of research undertaken in earlier projects. Thailand is a regional leader in animal disease control and manufactures its own vaccines through a government Bureau of Veterinary Biologics. They approached ACIAR to assist with **aspects** of vaccine manufacture, particularly as it relates to foot-and-mouth disease vaccine and establishment of Good Manufacturing Practice that will meet international certification. ACIAR has already supported an evaluation of the vaccine supply and manufacture in Laos, and one of the outcomes of that review was to develop a work plan for its vaccine manufacturing centre that will lead to improved quality of the vaccines produced on site. This activity, involving liaison with consultants and scientists working on other ACIAR-funded projects in the region, will support the needs of the facilities in both Thailand and Laos.



Aquaculture farm established as part of the ACIAR-World Vision project work in north-east Thailand.

In 2001 ACIAR and World Vision Thailand implemented a program of collaboration to foster greater application of the results of earlier ACIAR-funded research. Three programs—on fish-feed production, temperate fruit development and production of vegetables with reduced use of agrochemicals—helped World Vision to address specific technical challenges that communities had identified in different parts of the country. The projects were implemented in some of



ACIAR Commission Chair Dr Meryl Williams and Governor of Udon Thani province inspect smallholder frogs at the World Vision aquaculture project

the poorest parts of Thailand and produced significant community impacts. A newly commissioned project follows this model. It focuses on **improving the reliability of rice and livestock-based farming systems** in Mahasarakham Province in north-east Thailand, one of the poorest parts of the country and which suffers from low soil fertility, salinity and acidity. The project also aims to further develop the paradigm of participatory research to assist World Vision agriculturalists working with farmer groups.

The Thai Department of Fisheries are providing assistance with the Lao Fish Passage Development Program supported through another ACIAR project. The original project helped the Thailand Department gain experience with fish passage technology through biological assessments and study of traps and transport 'fishways'. This project is providing Thai fisheries researchers with the opportunity to value-add to the existing assessment of fish passage in Lao, through participation in the work. These collaborative efforts will help to consolidate existing work in the wider Mekong regions and to develop a plan to improve opportunities for fish passage in Thailand and Lao PDR.

Researchers examined the impact of sanitary and phytosanitary measures on the ability of (agricultural exporting) developing countries to achieve the full benefits of trade liberalisation through a comparative study of India and Thailand. Particular emphasis was placed on the role of the Sanitary and Phytosanitary (SPS) Agreement and the related WTO dispute settlement procedure in cushioning exporters of agricultural and food products against trade-retarding effects of SPS measures. The work also emphasised related compliance issues and institutional constraints. In early 2008 a major research monograph was published, while a short policy manual targeting public-sector and private-sector organisations engaged in addressing food safety standards and export performance was published concurrently.

Burma

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AOP budgeted expenditure in 2007-08	\$163,362	unpa
Actual expenditure in 2007–08	\$167,562	orn S
Expenditure in 2006–07	\$203,325	Chirat
Expenditure in 2005–06	\$208,998	Khun

Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
Selection and introduction of improved legume varieties and enhanced inoculation techniques suitable for the central dry zone of Burma	The project on enhanced legume cultivation in the Central Dry Zone of Burma conducted workshops to promote the use of improved rhizobial inoculants. A number of field trials are in progress under different agro-ecological conditions to identify promising management practices to improve the production of chickpea, groundnut and pigeon pea.

Position

In 2007–08 ACIAR supported two projects in Burma, both having the humanitarian focus of the impact of improving nutrition and food security (either directly, or through enhancing farmers' cash incomes).

Achievements

A recently concluded project has focused on improving food security, nutrition and income of villagers in Burma by addressing constraints to productivity of scavenging village chickens. Farmers rank chickenkeeping as their second most important wealth producing activity after crop production. A major component was a series of epidemiological studies conducted to identify the major constraints to village chicken health and to evaluate strategies to improve village production. Mortality in young chicks and deaths from Newcastle disease were found to be two major constraints. These issues were addressed in a 12-month intervention study with Newcastle disease vaccination and improved management applied to randomly selected flocks. This

work demonstrated a significant increase in the number of birds sold after a period of six months in the group of farmers who introduced changes to the management of young chicks, resulting in additional income from the sale of birds. The number of households consuming home-produced chicken meat also increased in this group.

ACIAR Country Manager

In the Central Dry Zone of Burma farmers primarily grow legumes with minimal inputs of fertilisers, pesticides and herbicides, and yields are low (about 1.0 t/ha). A project led



Village chickens



Farmer transporting rice straw

by ICRISAT is identifying and distributing high-yielding chickpea, peanut and pigeonpea cultivars adapted to the cropping systems of the Zone. Results from the first year of farmers' participatory varietal selection trials have given scientists a better idea as to which varieties of the three legumes are preferred by the farmers in the different parts of the Zone. The project team is also seeking to increase the productivity of legumes by selecting and testing high-quality rhizobial inoculants (nitrogen-fixing bacteria that live in the root nodules of legumes). Sixty-three field trials were conducted in farmers' fields (26 for groundnut, 19 for pigeonpea and 18 for chickpea) with two treatments to test the effectiveness of rhizobium (+ inoculation and no inoculation). There were promising responses to inoculation at many sites and marginal improvements in crop colour. The next stage of the project will lift the capacity of the Rhizobium laboratory to produce large volumes of high-quality inoculants as a basis for more comprehensive testing in the field.



Yangon villagers sift rice after milling

South Asia

Financial year	Regional expenditure	Percentage of total project expenditure	Commission target as percentage of expenditure
2007–08	6,199,724	14.5%	<15%
2006–07	5,933,376	15.1%	<15%
2005–06	5,285,715	15.0%	<15%

ACIAR's South Asia program operates in two groups of countries. The first—India, Pakistan and Bangladesh—where most of the population is centred, is emphasized in ACIAR programs. A small number of activities are underway in the second grouping compromising Nepal, Bhutan, Iraq and Afghanistan. For the region as whole the expenditure target of not more than 15 per cent of our overall annual research expenditure has been set.

India	86
Pakistan	92
Bangladesh	96
Other countries	98
Afghanistan	98
Bhutan	99
Iraq	100



India

AOP budgeted expenditure in 2007–08 \$2,890,022		
Actual expenditure in 2007–08	\$2,825,837	
Expenditure in 2006–07	\$2,411,093	
Expenditure in 2005–06	\$2,761,952	

Dr Kuhu Chatterjee, ACIAR Country Manager, India

Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007-08
An integrated cluster of linked projects designed and implemented around sustainable wheat farming systems in north-west India	It was agreed with the Indian Council for Agricultural Research to further focus around a program on using marker-assisted selection to enhance breeding of new wheat varieties, focusing on biotic (stem rust), abiotic (water logging, drought tolerance) and quality traits. The first two of six components have been implemented, another three are well advanced in design.
Improved soybean–wheat production systems being tested by farmers and propagated by NGOs in Madhya Pradesh	Nutrient management strategies for soybean- wheat cropping systems are being disseminated through a program established by farmers and supported by NGO staff. The trials confirmed the experimental results and provided a useful extension tool, establishing almost 100 sites. Adoption of these strategies, which involve an increased input of commercial fertiliser, will provide a clear confirmation of the approach, particularly in the current climate of rapid escalation of fertiliser prices.
Economic trade-offs of water allocation scenarios in the Krishna Basin quantified and communicated to water policy decision- making at national and state levels	Results using a framework to determine the value of different water uses were discussed during three stakeholder workshops in Andhra Pradesh, Karnataka and Maharashtra. Although the value of water for urban and industrial uses is substantially higher than for irrigation, feedback from water policy-makers is that social dimensions of water use may override purely economic evaluations.
A new collaborative program marker- assisted breeding in wheat developed	Successful program implementation has been followed by the addition of a bioinformatics component to extend impact.
40 per cent of new projects designed to have significant farmer or policymaker impacts within five years of completion.	All three new projects implemented in 2007–08 were designed as 'short time to impact' projects. In addition, three Small Research Activities were initiated, two of which have elements of early uptake.

Key performance indicators	Performance 2007–08
Demonstrated influence of policy research outcomes on trade and water policy decision-making processes	A project on trade liberalisation and domestic market reforms in Indian agriculture evaluated the impact of domestic market and international trade policy reform options on agricultural prices, production, incomes and consumption. Workshops used to disseminate policy recommendations to key stakeholders. Briefings of water policymakers conducted in three states on water allocation in the Krishna Basin and options to optimise state- wide water allocation.

Position

The emphasis of ACIAR's India program is on maintaining sustainable wheat-based cropping in the more favoured areas of north-western India, achieved through application of better genotypes, better management technologies, and increased linkage of farmers to markets. In the less favoured areas of India's rainfed Central Plateau, the emphasis is on broad-scale land and water resource management work, applying technical, economic and policy research approaches to increase water productivity. Both themes will be complemented by more general policy analysis work at the national level.

Achievements

Subprogram 1: Sustainability of wheat-based cropping systems in north-west India

As the scope of this subprogram is further tightened to focus primarily on marker– assisted breeding of wheat, a range of ongoing projects addressing the broader issues related to sustainability of wheat-based cropping have continued to progress very well.

Significant progress has taken place in the project to establish **zero-tillage in rice cropping in rice and wheat.** During 2007, researchers identified and developed suitable establishment systems for direct seeded rice as an alternative to the traditional hand transplanting method. At field sites across the states of Haryana, Punjab and Bihar yield responses for coarse grain and basmati rice types were generally similar under comparative evaluations of direct seeding with the traditional hand-transplant system. Only at Kapurthala in the Punjab, which has a sodic soil, were rice yields significantly higher (44–85 per cent) under the traditional hand-transplant system. By contrast, rice established under zero tillage at Pusa in Bihar yielded significantly more grain (9–39 per cent) than the traditional hand-transplant system, and higher yields (8.3 t/ha) were obtained with zero-tillage



A local woman involved in the manual harvesting of wheat in Faizabad, Uttar Pradesh



Project team working on improving root traits and drought tolerance of wheat

machine-transplanted rice than with conventional puddled transplanted treatment (7.5 t/ha) at Kurukshetra research station, Haryana.

Waterlogging adversely affects 10–15 million ha of wheat each year, in soils ranging from the heavy clay alkaline/sodic soils of northern India to the acidic sandy duplex soils of Western Australia. There is evidence that every time wheat is irrigated in the heavy soils of India it becomes waterlogged. Scientists have investigated the genetic diversity for waterlogging tolerance in wheat, evaluated mechanisms of tolerance, and used this knowledge to develop new waterlogging-tolerant breeding lines for specific target environments. They have now established a genebank of these new lines, and the project is poised to capture the benefits of the work through the development of high-performing varieties.

A project focusing on **integrated manure nutrient management** seeks to overcome nutritional limitations in the soybean–wheat cropping system of the monsoonal environment in Madhya Pradesh. Scientists have tested an integrated nutrient management (INM) approach where the use of farm yard manures (FYM) is combined

with inorganic fertiliser, and demonstrated that substantial benefits can be gained from a smaller application of manure (5 t/ha) that permits farmers to treat a larger cropping area each year. Even so, there is insufficient manure available and an inorganic fertiliser regime termed balanced fertilisation (BF) seems necessary. In 2007-08 the project team evaluated INM and BF using a 'Baby Trial' strategy. In the Kharif (monsoon season) soybean crop, inorganic fertilisation produced yields 23 per cent greater than the farmer's practice while the INM approach produced yields 46 per cent higher. During a farmers' field day, farmers attributed the higher soybean yield under INM to better pod bearing relative to BF. Where farmers maintained effective control of weeds and pests the yields were even better, illustrating the beneficial impact of farm management on fertiliser practice.

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

Better water management is one of the highest priorities for improving livelihoods in the more marginal rainfed areas of central India. Water harvesting, as part of a broader watershed development agenda to increase water availability, is a key policy initiative of the Indian Government in these areas. At the same time, there is increasing competition for water as basins become fully allocated. Work in this subprogram is progressively being streamlined to a cluster of closely linked projects to enable a more holistic approach to water resource management.

Research has continued into water availability and allocation issues in India's Krishna Basin. This is an almost closed basin (i.e. all the water available is fully allocated to some purpose for a large part of the year) populated by some 73 million people, and the system is already severely short of water. During 2007–08 the team brought together much of the initial project thinking and activities into a set of models that explain the allocation of water in three sub-catchments within the basin. In April 2008 high-level officials from all three states visited Australia to gain an insight into the challenges and opportunities of aspects of water management in the Murray-Darling Basin, with a focus on how to cope with the problems of water scarcity. This tour provided a forum for exchanging ideas and initiated a process of harmonising the conflicting positions held by individual states and their policymakers in regard to the even more acutely water stressed Krishna Basin.

Smallholders in watersheds of the East India Plateau stand to benefit **from water harvesting and better cropping systems.**



Villagers construct seepage pit to capture shallow ground water for irrigation



Women at the waterhole in Rajasthan

They have continued to participate fully and with increasing enthusiasm in the action learning cycle of planning, doing, observing and reflecting. A Village Core Committee has improved project implementation by shifting ownership and responsibility for trial site selection and management from the project team to the farmers. This large group of subsistence farmers has undertaken business-like planning of a research project, indicating development in their capacity to deal with complex issues and integrate them into village life. The high standard of management at trial sites and the reduced level of team support needed are indicators of the success of these moves.

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

Creating the right policy environment for reform in the agricultural sector has the potential to deliver major impacts. Hence, ACIAR retains some projects aimed at assisting India with the implications of its transition from a highly regulated economy to a more open market economy.

An important study on **agricultural trade liberalisation and domestic market reform**

Marker-assisted selection promises more efficient wheat breeding

ACIAR and the Indian Council of Agricultural Research (ICAR) have engaged in collaborative research for 25 years. One of two main emphases in ACIAR's India program in recent years has been sustainable wheat-based cropping.Project work arising from this focus area takes place in north-western India, where researchers have sought improvements through better genotypes, improved management technologies and enhanced linkages of farmers to markets.

Now, after a review of priorities in 2007, ICAR and ACIAR have agreed to gather sustainable wheat cropping activities into a program based around the application of marker-assisted selection (MAS) to achieve greater efficiencies in wheat breeding. Efficient new wheat cultivars of better yield and guality are increasingly necessary in the global environment, particularly in India where population growth is leading to major stresses on natural resources. As such, the primary objectives of the collaborative multiinstitutional network plan are: 1) to identify new markers that may be utilised to convey higher tolerance to abiotic stresses and additionally provide new or strengthened resistance to biotic stresses; and 2) to develop new wheat germplasm in shorter

was completed, including a workshop for Indian researchers and decision-makers to consider the results in June 2008. Indian agriculture remains subject to a wide range of government regulatory impacts and market distortions. The project has broken new ground in assessing the impacts of current policy and institutional settings alongside domestic market and trade policy reform options. The project has provided Indian time spans using MAS, thereby resulting in the rapid deployment of superior wheat varieties.

This new approach represents a paradigm shift in ICAR–ACIAR collaboration, away from a portfolio of projects to a more closely planned and integrated overarching program. It takes into account both Indian national agricultural priorities and the key themes for which synergies can be achieved by the two countries. The program structure also recognises the advanced research capabilities in both countries, and ensures sharing of program costs and benefits by the partner countries. A new ACIAR-commissioned project 'Molecular markers for faster wheat breeding' has a central and catalytic role in the program.

As a first step in defining the priorities for this new Indo-Australian Program a joint workshop was held in Delhi in October 2007 where participants determined the role of the Indo-Australian Program on Marker-assisted Wheat Breeding (IAP-MAWB). Given ACIAR's move towards funding projects with shorter time to impact, the IAP-MAWB will focus on MAS applications, trait testing and marker validation to form the core of a broader Indian wheat breeding program.

policymakers, researchers and advisers with a review of the main institutional and regulatory interventions; a case study analysis of marketing system constraints and impacts in selected agricultural sectors; an evaluation of the economic impacts of domestic and trade policy reform options together with a set of policy recommendations to achieve more efficient markets. A key finding was that trade policy reform must



Transplanting rice

be complemented by 'behind the border' domestic reforms if government is to achieve their objectives of improved productivity, higher rural employment and incomes and enhanced food security. A follow-on project on facilitating efficient agricultural markets in partnership with the influential Indian National Centre for Applied Economic Research (NCAER) has been contracted in 2008. This research institute will further analyse domestic regulatory reform applications with guidance of policymakers in relation to the range of available competition policy mechanisms and their applications in particular circumstances. Australian experience and expertise in this matter and comparisons with other relevant developing countries will be used in the analysis.

Other projects

Excellent progress has been made in developing **aquaculture in degraded inland areas** in India and Australia. In India the project has focused on development of technology for hatchery and growout production of the giant freshwater prawn, *Macrobrachium rosenbergii*, in shallow watertable saline groundwater. Major achievements include identification of ionic imbalances of potassium, calcium and magnesium in raw saline groundwater compared with seawater. The scientists have developed a cheap, efficient method to ameliorate these imbalances and make the saline groundwater suitable for *Macrobrachium* larval rearing, and now many thousands of post-larval juveniles are available to local and interstate commercial and research facilities. Following the success of the project the Indian institutions have recognised inland saline aquaculture as an important niche area of research and provided significant funding to advance the work.



Smallholder prawn ponds under cultivation in Andra Pradesh

Pakistan

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AOP budgeted expenditure in 2007–08	\$2,053,130	ie, anage
Actual expenditure in 2007–08	\$1,942,917	atterje try Mc
Expenditure in 2006–07	\$1,708,789	hu Ch Coun an
Expenditure in 2005–06	\$1,095,670	Dr Kul ACIAR Pakist

Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
Significant exposure of Pakistan researchers and extensionists to modern methods of knowledge transfer and agricultural extension in dairy production	160 farmers from two areas of Punjab state engaged in three different extension approaches involving a range of providers (NGO, dairy cooperative, government extension agency). Pilot trials are being complemented by interactive workshops to introduce Australian extension expertise to scientists, academics and extension workers.
Bed planting and residue management systems using locally manufactured machinery achieving significant saving in irrigation water	The 'National Project to Stimulate Adoption of Permanent Raised Beds' has commenced the roll-out of permanent raised bed (PRB) technology. In 2008 at least 20 units of PRB machinery had been ordered by farmers, and three local companies are manufacturing PRB machinery based on ACIAR project designs. The introduction of 'Happy Seeder' technology in two regions of Punjab has led to more than 150 ha of wheat being planted using the new planters, with the area likely to double in the coming wheat season.
Mango supply chains mapped and opportunities to improve value generation identified for selected domestic and export markets	Domestic and export (UK, Dubai, China, Singapore) mango supply chains have been mapped and assessed and opportunities to improve value generation have been identified. These include lime-based de-sapping of fruit to control sap-burn, improved handling and packaging, changes in harvest maturity of fruit, storage conditions and grading. These improvements are currently being adopted by growers.
40 per cent of new projects designed to have components leading to significant farmer or policy impacts within five years of completion	Each of the two projects that commenced in 2007–08 has components likely to deliver short-term impacts. One will optimise canal and groundwater management to assist water-user associations in maximising crop production and managing salinisation. A second project on enhancing dairy extension systems will train extension providers in better delivery methods and supply more relevant material.

Position

ACIAR has broadened the program of bilateral and multilateral projects in Pakistan to encompass the horticulture and dairy sectors. These build on a longer term focus on natural resource management issues such as efficient water use, salinity and drainage, and tillage options for irrigated cereal cropping. The broadened focus arises from the Australia– Pakistan Agriculture Sector Linkages Program (ASLP), which ACIAR is implementing on behalf of AusAID.

Achievements

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

The horticulture sector in Pakistan is significant both domestically and for export production. A problem common to both mango and citrus is major losses due to poor harvesting practices, packing and transportation. With production, key issues are inadequate orchard and irrigation/drainage management, and major diseases.

Research under the ASLP has continued. A project to optimise mango supply chains for more profitable horticultural agri-enterprises has seen the introduction of simple techniques to increase the shelf life and the quality of mangoes through the practice of limewashing. Use of the process has positioned the Pakistan Horticulture Development and Export Board (PHDEB) to target the high-end European market. Initial batches of high quality, limewashed mangoes have achieved three-five-fold higher prices, and the Export Board is now poised to enter new export markets in Germany. This will help increase volume and value of mango exports from Pakistan.

Another breakthrough has been the discovery of the main agents causing the **Mango Sudden Decline Syndrome**. Prior to the ASLP, conflicting diagnostic protocols and



Dr. Saeed Shafqat and PhD student inspecting research on the role of bark beetle on mango sudden death syndrome

fragmented research gave an uncertain picture of causal agents, and development of effective disease control practices was impossible. Now the scientists have a basis for developing a range of recommendations, and this should lead to effective mango decline control measures within the life of the project.

In a project to increase citrus production in Pakistan and Australia through improved orchard management techniques, the researchers tried unsuccessfully to match climatic areas of interest in Pakistan with Australian citrus-growing areas, highlighting the need for additional crop phenology research in Pakistan. Budwood for 23 cultivars together with eight rootstocks have been sourced elsewhere and are now growing successfully at the University of Agriculture Faisalabad. In another component, efforts are underway to modify the flood irrigation system to an under-tree furrow irrigation system. Extension activities to lift skills in plant propagation and nursery production techniques have been boosted by an instructional DVD modified for Pakistan by the NSW Department of Primary Industries.

Subprogram 2: Improving livelihoods of dairy farmers

Dairy is the largest livestock sector in Pakistan, with demand for milk and milk products

Upswing of activity as ASLP gains momentum

Since 2005 ACIAR has managed the Australia–Pakistan Agriculture Sector Linkages Program (ASLP). The main goals of the program are to transfer Australian knowledge and expertise to key sectors of Pakistan agribusiness to increase profitability and enhance export potential; to contribute to poverty alleviation of smallholder farmers through collaborative research and development; and to enhance the capacity of the Pakistan research, development and extension system to deliver targeted and practical research outputs to agribusiness and farmers.

The program is based around two thematic priorities—horticulture and dairy. ACIAR's core program complements the ASLP through a broader focus on land and water resources, encompassing community-driven water allocation and drainage management as well as irrigated cereal production.



Prior to the ASLP, the level of ACIAR exchange with Pakistan was restricted to a project-by-project base. But the ASLP has led to a routine engagement between ACIAR and the Planning Commission, the Federal Ministry of Food, Agriculture and Livestock, the Pakistan Agriculture Research Council and the Punjab and Sindh Departments of Agriculture. Such liaison is enabling a far broader exchange of expertise between Pakistan and Australia, extending beyond the ASLP's immediate emphasis on horticulture and dairy to issues of water management and disease threats (e.g. avian influenza, Ug99 wheat stem rust). It is also underpinning the broader capacity-building support by helping Australian universities to link with partner universities in Pakistan and by helping to place Pakistan-funded postgraduates in Australia.

All four R&D projects implemented under the ASLP are now fully operational and, in some cases, early results indicate that project activities are exceeding expectations. Although significant impact of R&D activities is normally observed toward the completion of projects and beyond, there have already been a number of encouraging outcomes, as demonstrated by the examples given in the adjacent report.

growing at about eight per cent per annum. Despite good genetic potential among animals, production is low due to poor nutrition, mismanagement, failure to control diseases, and lack of proper marketing of this highly perishable commodity. This is compounded by a fragmented research effort and weak extension support services. Much of the technology required to boost efficiency of the **Pakistani dairy industry** is available but not readily disseminated nor adopted by the farming community. A project, also part of the ASLP, is seeking to demonstrate the economic and social benefits of improved extension services to smallholder dairy farmers and to capture, enhance and disseminate knowledge relevant



ACIAR is working with dairy producers as part of the ASLP to improve animal nutrition and disease control to increase milk production and meet the rising demand for dairy products within the domestic market

to smallholder dairy systems. Already there is evidence of enhanced linkages in Pakistan across the research-extension-farmer continuum. As a result farmers are now receiving unambiguous extension messages, research programs are far less fragmented and, most importantly, a farmer demanddriven research mindset has been instilled in Pakistan. A major facet of the work is a survey to identify the key limiting elements for production on small farms in two disparate regions of Punjab. The data being collected cover all aspects of the farm operation including production, feeding, reproduction, animal health and, where possible, farm budgets over a two-year period.

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

ACIAR's program in Pakistan has had a longstanding focus on improving the management of land and water resources, given the similarities with Australia. In attempts to reduce the incidence of residue burning in rice–wheat systems of Pakistan, the Farm Machinery Institute (FMI) in Islamabad has designed and built a prototype machine (the 'FMI Seeder') for **managing rice stubble and** **direct seeding** in a single operation. The seeder, which is based on a similar machine developed in another ACIAR project in the Indian Punjab, is now undergoing assessment for performance under a range of stubble, soil and seasonal conditions. On the basis of last year's test results researchers have made two main modifications to the Mark-III model of FMI Combo Seeder. In a further development, the 'FMI Rocket Seeder', has been developed for a lighter and more vigorous straw cutting. A simple straw spreading kit, seen as a prerequisite for the adoption of the seeding technique, was also developed for all common models of combine harvesters.



A Farm Machinery Institute drill in heavy rice stubble, Lahore

Bangladesh

AOP budgeted expenditure in 2007–08	\$553,303
Actual expenditure in 2007–08	\$533,866
Expenditure in 2006–07	\$481,224
Expenditure in 2005–06	\$538,454



Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
Extent of water resources available for supplementary irrigation to facilitate expansion of rabi cropping in southern Bangladesh determined	Preliminary estimates at smaller scale (300 ha) have been completed, indicating that the amount of surface water stored in ponds would be sufficient to irrigate a third of the cropped area. The above analysis will be extended to a larger area once data on shallow groundwater tables have been sourced.
Improved crop establishment techniques for legume planting in north-western Bangladesh designed and tested	Several low-cost planters suitable for small two- wheel tractors developed and tested across sites with different crop and soil conditions. The planters greatly increased the time windows of legume planting and achieving equal or higher yields.

Position

ACIAR's strategy in Bangladesh is to focus on agronomic and biotic constraints to the production of broadacre grain crops, especially the 'Rabi' or winter season crops, such as chickpeas, lentils, wheat and maize.



A local and Australian scientist discuss the benefits of conservation tillage for cereal production

This is done either through bilateral projects or projects led by the International Agricultural Research Centres that link to existing programs such as the Rice–Maize Alliance between the International Rice Research Institute and the International Maize and Wheat Improvement Center.

Achievements

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 conducting a program to **increase the production of chickpea and lentils** in this region. In the second year of the project the sharp rise in prices of internationally traded grains, fertilisers and fuel has highlighted the opportunities and threats for pulses in Bangladesh. Pulses remain highly profitable, but the rising price of maize, wheat and Boro rice has reinforced the view that project



Scientists and farmers involved in the development of conservation farming techniques (power tillers) discuss the current limitations of existing machinery

research should specifically target those areas with limited or no irrigation so that the Rabi (dry) season pulses, chickpea and lentil, are not grown in direct competition with cereals. Two seasons evaluating both chickpea and lentil have shown that reasonable yields can be obtained provided the recommended integrated crop management package is followed. Molybdenum and Rhizobium were also needed, but additional responses to lime suggest that in northern districts other soil acidity constraints exist. A sub-sector analysis under way for lentil and chickpea in north-west Bangladesh will identify the key bottlenecks for expansion of chickpea and lentil production and provide a framework for their further promotion.

Farmers in southern Bangladesh currently depend primarily on one wet-season rice crop per year to provide income for their families, meaning that around 800,000 hectares lie uncultivated during the Rabi season. This is primarily because irrigation resources are limited, but other constraints also add to the perception that the area is too risky for wheat in a rice–wheat rotation. A project building on earlier research funded by ACIAR and FAO aims to address the **constraints of water and unsuitable** **management practices**, thereby improving the livelihoods of these farmers by making their fallow lands productive during the post-rice Rabi season. The excellent wheat yields achieved in successful projectsponsored farmer trials during the 2007–08 season, combined with current high demand and record prices for wheat grain in local markets, have created exactly the right ingredients to encourage further Rabi cropping in southern Bangladesh.



Traditional ploughing in Bangladesh villages

Other South Asia countries and the Middle East

AOP budgeted expenditure in 2007–08	\$515,717
Actual expenditure in 2007–08	\$897,104
Expenditure in 2006–07	\$1,332,270
Expenditure in 2005–06	\$889,638

Expenditure includes both bilateral and multilateral projects

Key performance indicators	Performance 2007–08
New project activities initiated in Bhutan supporting the key agricultural export product, citrus	In project HORT/2005/142 new activities including establishment of best practice trials sites and training of local researchers and growers in plant propagation and other production techniques in both Bhutan and Australia have been initiated.
Best bet varieties of a range of suitable crops and technologies identified and being tested in dryland farming areas of northern Iraq	Successful germplasm testing has been complemented by significant impacts with zero tillage options in farming communities.
Dissemination of promising wheat and maize varieties and further training of Afghan scientists and NGOs	From wheat and maize introductions, three wheats have been released. In-service training was provided for 25 Afghani scientists at International Maize and Wheat Improvement Center (CIMMYT). All but one of these remain with their sponsoring institutions.

Afghanistan

Position

Two decades of war coupled with a recent severe drought devastated Afghanistan's food-production capabilities and depleted



critical seed stocks, leaving the nation heavily dependent on food aid from international donors. ACIAR's multilateral project in Afghanistan provides support to wheat and maize production.

Achievements

During 2004–07 CIMMYT, through its country office in Kabul, implemented a joint AusAID– ACIAR-funded project with the overall aim of achieving a **sustained increase in wheat and maize production and productivity** in Afghanistan through research, training and technical interactions. The project operated and delivered outcomes in an environment that continues to present logistical and security challenges. In particular, the project successfully developed networks with a number of organisations operating in Afghanistan and leveraged considerable extra resources to help fulfil the aims of this important project.



An Afghan farmer in his maize crop

The Afghanistan Ministry of Agriculture, Irrigation and Livestock is committed to rebuilding agriculture in Afghanistan and has developed an Agriculture Master Plan which places a strong emphasis on cropping and capacity-building. In line with that Plan, a new project is focusing on the introduction and screening of new wheat lines with a particular emphasis on resistance to yellow rust and stem rust (including Ug99). It is also supporting the release of new high-yielding varieties and the production and dissemination of quality breeder seed. It especially seeks to gain more knowledge of agro-ecological wheat production zones in Afghanistan in order to better target the new varieties so that they meet the needs of farmers and consumers in these different zones.

Bhutan

Position

ACIAR's small program with Bhutan began in 1998. Because of Bhutan's relative lack of capacity to effect significant change across many agricultural sectors at once, the program remains small and very tightly focused. Earlier ACIAR research to develop Newcastle disease vaccine for village chickens was extended and adapted for the situation in Bhutan with the help of AusAID funding, and projects were initiated on the management of fruit flies, and on footrot management in ruminants. The current program emphasis is on improvement of citrus production (Bhutan's largest horticultural export industry), the implementation of pest and disease management, and a smaller study on water and land management.

Achievements

A study to find opportunities to improve land and water management in Bhutan has focused on Eastern Bhutan where poverty levels are greatest. Bhutan places high priority on protection of natural resources and, while concerns had been expressed in the country about soil and water management issues related to agriculture, few had been investigated. A study identified land slips as a major contributor to river sedimentation, increased by anthropogenic factors such as inappropriate road construction. A less important contributor was poor maintenance of the canal system used for irrigation water reticulation. There was little evidence that arable 'dryland' agriculture contributed to serious gully or sheet erosion, despite the high rainfall, steep slopes and traditional tillage practices. Nevertheless, land was at risk of erosion between the first and second crops in the wet season, and there was a need for research and extension to develop and promote soil-conserving tillage practices.

A project to improve mandarin production in Bhutan and Australia through the implementation of on-farm best management practices was launched in June 2007. Four demonstration orchards have been established. Basic improvements such as basin formation to allow for application of water and inorganic fertilisers and the clearing of vegetation under trees were the first activities undertaken. Soil and leaf samples were collected and analysed and a basic fertiliser program started in February 2008. Selected trees at each of the sites have been pruned to varying degrees to assess the timing of operations and tree response in Bhutan. Three Bhutanese project members have visited Australia for formal training in soil and irrigation management, citrus nutrition and citrus canopy management. They have undertaken practical instruction in pruning, budding, grafting and topworking of citrus. Visits to two commercial citrus nurseries provided them with an insight into nursery production practices in



Nursery establishment of new rootstock varieties to improve mandarin production in Bhutan

Australia. They also visited a commercial citrus packing company and juicing plant to look at postharvest operations and facilities.

Iraq

Position

The high levels of input subsidies, guaranteed commodity prices and free food distribution have distorted agricultural markets in Irag and have provided little incentive for innovation by farmers. In addition, scientists have had limited access to international developments in the agricultural sector for over two decades. ACIAR is managing one project in Iraq, co-funded by AusAID. The project is intended to assist the Iraqi Government in its quest to modernise agricultural markets and production systems. It is anticipated that support will be limited to this project in the short- to medium-term as Iraq passes through a critical period of development.

Achievements

Iraqi farmers are moving from a heavily subsidised to a commercially-oriented agriculture. A project sought to introduce better crop germplasm and management for improved production of wheat, barley and pulse and forage legumes while reintroducing Iraqi scientists and farmers to international level research and production technologies. It focused on cereal production in the northern low rainfall zone where 70 per cent of cereals are produced.

The approach adopted was to draw on expertise in Iraq, ICARDA (Syria), Australia and elsewhere to design some 'best-bet' production systems combining crops, cultivars and tillage practices. The decision was sound and the 'best-bet' practices were well chosen. Demonstrations of cropping systems have now been maintained for three years at several locations in three rainfall zones and have given the project the impetus it requires for early impact.

The significant success of the project to date has been the introduction of zero tillage as a soil and crop management option for Iraq. This management system is well suited to low rainfall areas where it offers at least equivalent yields but at smaller production cost than conventional tillage, while improving soil quality and protecting it from wind and water erosion. The economic advantages have special attraction to Iraqi farmers faced with greatly increased fuel costs now that they no longer receive a heavy subsidy for their agriculture.