

Appendixes

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Appendix 1a: ACIAR's sectoral strategies for 2008–09

Field crops

ACIAR targets issues of the major field (broadacre) crops that can have either genetic or agronomic solutions. The emphasis is on crops for which Australia has strong expertise (e.g. wheat, canola) as well as newer crops for which Australia can share mutual benefits by exchange of germplasm with partner countries (e.g. faba and other beans, chickpea, lentils). ACIAR projects in this area often complement or directly support the efforts of CGIAR centres relevant to both the Asia and Pacific regions. In addition, broader system questions such as water and fertility management, tillage and crop rotations, and genetic limits to yield potential are addressed in the context of field crop systems.

ACIAR-supported **crop improvement** work encompasses germplasm collection and evaluation aimed at improving selection efficiency, plus more conventional breeding projects for the introduction of important new traits into existing cultivars. We are also interested in the **development and application of improved selection tools in crop breeding programs** that: enable parental material to be better characterised; identify physiological traits closely related to crop performance; use molecular markers to speed selection programs; and enhance information management to increase efficiency of plant selection and breeding.

In **biotechnology**, ACIAR will focus on plant genetic improvement rather than on new technology development. This includes support for transfer of proven biotechnologies such as plant tissue culture and molecular markers to assist in the identification of potentially useful genes for crops relevant to developing countries. A limited number of plant genetic engineering projects will target areas where improvement is difficult to achieve through conventional breeding and where there are regulatory systems in place that support the use of engineered crops. We usually build upon existing capacity in biotechnology rather than establish the skills and facilities from the beginning. Linkage of biotechnology research groups to crop improvement breeding programs in partner countries is critical.

Cropping systems research encompasses a broader range of applications of proven technology, focusing on soil fertility and conservation tillage.

Research in **maintenance of field soil fertility** will comprise:

- application of better soil- and crop-specific diagnostics
- the efficient use of fertilisers, ameliorants and animal manures
- the use of effective legume crops, forages and green manures
- the use of break crops and natural soil biofumigants
- testing of promising biofertilisers.

Research areas of interest in **reduced tillage and conservation agriculture** will focus on the development of systems that maintain surface residue cover to prevent soil erosion, improve water infiltration and build soil organic matter, including options to reduce the opportunity cost of retained crop residues. This will be underpinned by the development of appropriate tillage and planting machinery. Such applications-oriented work is supported by longer term research on **manipulating the soil-plant interface** to enhance and predict soil biological function, and is the basis for further optimising processes governing nutrient cycling, soil-borne disease suppression, and manipulation of the rhizosphere to maximise water and nutrient uptake.

Water-use efficiency in dryland cropping and irrigated systems will receive special emphasis, as Australia is also grappling with many of the productivity and sustainability issues experienced in similar environments in developing countries. Areas for research emphasis include cultivars bred for resistance to water and salinity stresses, and crop and soil management for improving water productivity (including improved agronomic practices and the use of raised-bed technology). In dryland subtropics there is scope for work on run-off capture and water harvesting for cropping in small watersheds.

ACIAR support for work on **grain postharvest technologies** will emphasise implementation of grain drying and storage technologies rather than new research, and include analysis of the economic and institutional constraints to adoption. Collaborative research is needed on emerging stored-product pests, including those resistant to current protectants and fumigants.

Horticulture

ACIAR's horticulture research aims to improve the productivity, profitability and sustainability of fruit, vegetable and ornamental crop production in developing countries and Australia. Emphases are to improve the utility and efficiency of supply chains, optimise the quality and suitability of produce for market requirements, and minimise pre- and postharvest losses of fruit and vegetable crops. The ACIAR horticulture program will increasingly focus on a complete **supply chain approach** to crop production, which will aim to identify and address multiple constraints to individual horticultural industry developments. Such constraints often arise simultaneously throughout the supply chain and can potentially reduce the impact of single-issue interventions.

ACIAR will continue to support research on management of pests and diseases and postharvest handling of major fruit crops, particularly tropical and subtropical fruits, as well as support work that integrates technology for fruit

production systems. There will be less emphasis on fruit germplasm selection and breeding because of long lead times to impact. ACIAR will significantly **increase its investment on vegetables** for developing countries. These provide opportunities for increasing cash incomes and improving nutrition in relatively short time frames. Vegetables such as sweet potato and other root crops are major staples for Papua New Guinea and Pacific islands countries, while potato demand is increasing rapidly in countries such as Indonesia. Short crop cycles for most vegetables provide opportunities for rapid adoption of technology and enable increased returns from limited land areas. Production, postharvest, marketing and value-adding research will increasingly be integrated and there will be greater emphasis on protected and peri-urban vegetable production. Ornamental crops are becoming increasingly important for income generation in developing countries. ACIAR will support ornamental crop research encompassing commercialisation of native germplasm, production and supply-chain technology for the mutual benefit of both developing countries and Australia.

Crop protection research will have four focus areas: a systems approach to improving pre-harvest crop productivity including integrated management of pests and diseases; biological control, incorporating the use of environmentally friendly approaches to pest, disease and weed control (including use of soft chemicals and biocontrol strategies); postharvest handling and disinfestation treatments; and improvements in biosecurity including application of diagnostics, pest and disease surveys, and surveillance and assessment of the quarantine risk of specific horticultural and plantation crops.

Plantation crops

Australia has less technical expertise in production aspects of plantation crops such as coconut, oil palm, coffee, cocoa, spices and essential oil crops, although their importance in partner countries such as Papua New Guinea and Indonesia is significant. However, Australia has substantial expertise in agronomic principles, crop protection, harvesting, postharvest, extraction technologies, and social and economic issues—and the integration of these disciplines. ACIAR will especially encourage linkages with private sector and industry organisations, as well as research providers, to identify quality factors that can be targeted for improvement to increase grower incomes through analysis of the production and marketing chains. It will also identify the social and economic incentives necessary to encourage adoption of high-value production or processing systems, and undertake research to improve quality, recovery and yield.

Crop pest and disease management

ACIAR emphasises sustainable management of pests in crops where losses are significant and for which standard chemical solutions may be either limited in effectiveness, environmentally unsuitable or uneconomic for developing-country smallholders. Recognising that one of the constraints to adoption of integrated pest management

(IPM) is the complexity of the approach and the subsequent high level of training needed for farmers, better methods of information dissemination will be supported. ACIAR will focus collaborative **biocontrol** research projects in South-East Asia, Papua New Guinea and the South Pacific where many pests not native to these regions are ideal targets for classical biological control. Initiatives include: identification of target pests, weeds and diseases where there is immediate availability of control agents; advice on safe operations in relation to quarantine and host-specificity testing; development of novel methods of mass-propagation of natural enemies for inundative release; and strategies for effective field application to achieve ongoing control. For some pests in certain environments, biocontrol methods have become routine, and technology application rather than research is required.

Animal health and production

ACIAR's investments in animal health and production will largely focus on issues that enable smallholder farmers to refine their livestock management toward production and income generation, in contrast to 'keeping' livestock solely as an asset. These issues include aspects of the market, such as prices, seasonal trends, product quality and market access (including biosecurity), that reduce the risks involved in moving from a household-based to a market economy. Development of health programs for country–species–disease combinations and other livestock husbandry technologies will be considered where clear institutional pathways for adoption of the results of research by smallholders exist and where Australia has experience and expertise.

The Animal Health program has a major focus on diseases of regional significance:

- **trans-boundary diseases** not present in Australia, with concerns being avian influenza, classical swine fever and foot-and-mouth disease of cattle and pigs. ACIAR's priorities are disease surveillance systems; timely and accurate diagnosis; effective and timely control programs; and adequate institutional, regulatory and policy support to implement control activity
- **zoonotic diseases** that affect labour productivity and human capital in smallholder systems and may impact on the marketability of the livestock commodity concerned. Significant diseases include leptospirosis (cattle, pigs), parasitic cestodes (pigs, goats, cattle), rabies (cattle, dogs) and *Trichinella* (pigs), along with newly emerging diseases such as avian influenza (poultry) and Nipah virus (pigs). Research will involve collaboration with human health professionals but concentrate on limiting the transmission pathway from animals to humans
- **diseases affecting production** through high mortality, reduced growth rates or low levels of fertility. These also constrain other inputs that are necessary for successful production systems. Approaches for the protection of flocks or herds against disease will be applied to village systems, where social and institutional arrangements for sustained use of disease management are in place

- **diseases affecting trade and market access**, which are often quite country- and commodity-specific.

The impacts derived will be reduced disease control costs, improved animal productivity, improved product quality and improved market access. Increasingly, the emphasis will shift from production-related diseases to those of national and regional importance (usually a rapidly spreading viral disease) and those affecting trade and human health.

Within each theme ACIAR will address gaps in the successful management of a disease, which may include defining the disease issue or problem, understanding the biology of the disease (epidemiology, modelling), improving the ability to detect diseases (pathology, refinement of old tests, development of new tests or platforms), application of diagnostic tests to disease surveillance systems and refinement of these systems, and development and application of control measures.

Ruminant nutrition and husbandry

Poor nutrition is the major constraint to growth, milk or wool production, and fertility of ruminants in the semi-arid tropics and subtropics. Problems relate to the quality and availability of feeds throughout the year and a poor understanding of how to best use on-farm and locally available feed sources to support production. Emphasis is placed on the development of options to meet or change the nutrient needs throughout the year, including maximising the value of the wet season and early dry season, reducing the nutrient demand during the dry season (e.g. through managing reproductive calendars, sale of stock), conservation of feeds, use of supplements, and development of better quality crop residues or cultivating forages that provide a higher quality component of the diet. Low reproduction rates are also common in these regions. This problem can be redressed partly by improved nutrition and disease control, and in some situations by managing the mating (and therefore calving) period and by strategic management of the offspring. In all these situations, social and economic issues play an important role in determining whether such options are appropriate.

Optimising crop–livestock systems

Most livestock (e.g. small and large ruminants, pigs and poultry) are integral components of complex crop–livestock systems. A significant proportion of the feed for these livestock is provided by the crops—grains and tubers, stover, green forage and by-products from processing—along with weeds within and around the crops. Livestock manures can significantly improve crop production and help maintain soil conditions, but more efficient systems are required. Building a complete understanding of the biological, social and economic aspects of these systems is necessary when determining intervention points and developing appropriate technologies for smallholder farmers. A high priority for future work includes the development of optimisation protocols for balancing the forage, crop, livestock, human capital and environmental components

of systems. ACIAR has invested in the assembly of current knowledge on forage production, and the distribution and use of this information is a continuing emphasis.

Smallholder dairy

The focus for collaborative research in dairy is on the temperate and subtropical regions of South Asia (particularly Pakistan), where dairy products are a major source of dietary protein and where smallholder producers have access to markets for their products. ACIAR does not support dairy research projects in the tropical countries of South-East Asia because these regions do not have a comparative advantage in dairy cattle production, and because more open international trade allows countries to emphasise their areas of comparative production and marketing. Emphasis is placed on researchable production constraints of these often mixed livestock–crop production systems, including improved feed use and quality, and changes in cropping systems to include higher quality feeds and supplements. Integrated approaches, involving socioeconomics, management, marketing and technical interventions will be encouraged. Milk processing to value-add and improve food safety, and dairy policy issues relevant to smallholders, are also priorities.

Pigs and poultry

ACIAR focuses on consistent production of a reliable product. Reducing feed costs is important, either through better use of commercial feeds or, in some cases, by replacing costly components of commercial rations with locally available cheaper components. Integration of health management for pigs and poultry, together with appropriate housing and nutrition, is critical as smallholders move from producing livestock solely for household purposes and start to enter the market. ACIAR's emphasis is on fostering such 'semi-commercial' systems, rather than traditional village poultry and pig systems, unless there is clear evidence that there are institutional and incentive structures for uptake of technology at the village level, and/or that the village systems are linked into the market. In situations where it is necessary to change the pig or poultry breed to meet a market demand, ACIAR may support the introduction of livestock with known adaptation to those circumstances.

Genetic improvement

ACIAR places less emphasis on livestock breeding, taking into account the long time-frames for development of stock with superior traits, and subsequent transfer of those traits to the smallholder community. Furthermore, major gains in performance of existing genotypes can typically be made by addressing feed limitations and health problems.

Capture fishery resource assessment and management

ACIAR fosters a precautionary approach to wild fisheries resource management and retains a clear focus on small-scale fishers and farmers. The emphasis is on assessment and management for sustainability of wild-harvest fisheries, including conservation and rehabilitation of the critical

habitats which support them. Australia shares international responsibilities with Papua New Guinea and Indonesia to sustainably manage cross-boundary fish stocks in the Torres Strait and Arafura Sea. Cooperative research on shared stocks can deliver strong mutual benefits for these resources, while providing the opportunity to enhance the capacity of partner countries to assess and better manage all exploited stocks—domestic as well as international. Illegal, unregulated and unreported (IUU) fishing is a major contributor to rapidly declining harvests from many wild capture fisheries, with the situation particularly acute in Asia. With Australia a leading participant in ongoing international efforts to combat this problem, it remains an area of active involvement for ACIAR.

Research areas of emphasis include:

- assessment of **stock status and the impacts of fishing** and other factors on multi-species fisheries
- the development of **management strategies** which successfully accommodate and integrate resource, environment and community concerns for sustainability and equity of access
- the establishment of locally effective policy settings and institutional capacity to **better control and manage IUU fishing**
- the evaluation of **artificial stocking** as a tool for rehabilitation and enhancement of exploited aquatic resources (including coral reefs, reservoirs and estuaries)
- pre- and postharvest interventions that improve **use of existing harvests**, reduce waste and eliminate undesirable harvest technologies.

Sustainable production of culture fisheries

Aquaculture has been the fastest growing food production sector in the world for the last two decades, with an overall growth rate of over 10% annually. However, the intensification of aquaculture is several decades behind animal production industries in capturing productivity improvements that are possible through the application of technology. The existing skill base in Australia in environmental management and animal and plant production sciences is increasingly being harnessed to solve the problems constraining aquaculture production. Key areas for ACIAR's support for aquaculture are:

- **domestication and breed improvement** of new and common species where these factors constrain sustainable and profitable aquaculture operations
- **improved nutrition**, better use of on-farm feed sources and development of cost-effective feed formulations, with emphasis on the reduced use of fish products, encouragement of low-polluting formulations and better feeding strategies
- the **diagnosis, control and management of aquatic diseases** as major threats to the long-term viability of intensive aquaculture, with particular emphasis on shrimp disease management in smallholder systems and

management of viral diseases in finfish

- **culture-based fisheries in inland water bodies** and integration of aquaculture into existing small-scale farming systems. There is an increased emphasis on freshwater aquaculture in Papua New Guinea and the Pacific, and a continued emphasis in South-East Asian partner countries
- **low technology mariculture, sea ranching and resource enhancement in coral reef environments.** The focus for this work will remain on advances in village-scale mariculture technologies (trochus, pearl oysters, spiny lobster, sea cucumbers etc.) with particular attention to the needs of Pacific islands nations and Indigenous communities in northern Australia
- **reduction of adverse environmental impacts** of and on aquaculture.

Forestry

The existing industry in some developing countries relies on the unsustainable harvesting of primary forests, involving rapid depletion of resources and environmental degradation that precludes major decline in economic returns. There is potential, however, for forestry to form the basis of new industries that would supply wood and non-timber forest products to international markets and boost income for national economies, while at the same time meeting local demand and providing environmental benefits.

Research supported by ACIAR aims to build the foundations for major forest industries in the longer term, while delivering impacts in the shorter term. Underpinning drivers are:

- development of **silvicultural systems**, especially **integrated agroforestry systems** producing both timber and non-timber forest products
- development of appropriate **genetic improvement strategies and technologies**, and deployment of improved germplasm, for developing countries
- development of more **efficient harvesting and processing** approaches and technologies to develop higher value products
- **management of threats** posed by pests, diseases, weeds and fire.

Over the last 20 years there has been a strong emphasis in ACIAR's program on introduction and use of Australian trees. While this emphasis will decrease in countries with a large existing base of Australian species, ACIAR projects will focus on genetic improvement that will produce products of higher value, provide greater returns to growers and support local processing industries. They will also focus on silvicultural systems that can optimise the potential of improved material and protect it from pest and disease threats.

Appendix 1b: Cross-cutting issues to be addressed in 2008–09

Quarantine and biosecurity

Quarantine is increasingly important for developing countries and Australia for two reasons—national biosecurity and facilitation of trade. ACIAR believes that the following areas for crop-based quarantine research cooperation will achieve significant impact:

- information on pest, disease and weed problems of partner countries: identification of species, determination of their localities, their effects on particular crops and strategies to minimise their numbers and damage
- improved diagnostic and taxonomic ability
- biological information on the habits of target species to underpin efforts on control and management
- collaborative research on disinfection technologies
- assistance with development of national quarantine policies, risk analysis protocols, incursion monitoring systems and management plans, and national plant and animal health strategies
- studies of the impact of sanitary and phytosanitary regulations and other technical barriers on developing-country food trade, and how to minimise negative effects.

In **animal and fisheries biosecurity**, emphasis will be on preventive control, advancing animal health through a mixture of strategic and applied research that addresses the total livestock production chain (and reinforces national biosecurity systems), where it will benefit smallholders. Emphasis will be given to projects that address diseases exotic (and a perceived threat) to Australia—such as foot-and-mouth disease in ruminants and classical swine fever in pigs—and on detection and management of zoonotic diseases. Involvement in improving the animal health skills and effectiveness of Asian partner countries has a direct benefit to the Australian livestock industry in that it supports Australia's disease-free status and improves Australia's capacity to diagnose exotic diseases.

ACIAR also supports work on **policy issues** in the regulatory and institutional framework on agricultural health, food safety and quality assurance systems. This is very relevant for international market access, cross-border and domestic trade, and public health. Gaps between individual national and international sanitary and phytosanitary standards and regulations need to be rectified. A variety of interrelated biosecurity issues in Asia and the Pacific remain inadequately understood or addressed, and ACIAR will maintain a significant emphasis on capacity building, with particular attention on regional approaches.

Agricultural sustainability research

ACIAR addresses both broad-scale aspects of the management of land and water resources as well as research designed in the context of a systems approach to conservation agriculture. Where appropriate, biophysical work is closely integrated with economics and policy research, which uses economic instruments and institutional reforms for efficient management of natural resources. Some major themes include the following:

- **Agricultural water management** research focuses on improving irrigation water-use efficiency in arid climates, particularly in well-endowed areas of the Indo-Gangetic Plains. There is also an increased emphasis on water management for agriculture in more humid countries of South-East Asia such as Vietnam and the Philippines. Application of existing knowledge on irrigation water scheduling and irrigation hardware and software to reduce excessive irrigation is also important. Demand management (including water pricing and related subjects) is a high priority, as are improved institutional arrangements for managing irrigation systems and groundwater use.
- **Agricultural land management in the less favourable areas of Asia** Land management research is directed to particular problem areas identified by our partner countries in the rainfed cropping systems of China, the Mekong Basin, the Philippines and India. It ranges from supporting crop diversification and water harvesting in infertile rainfed areas to improving sustained production from marginal upland and sandy coastal areas. On sloping marginal lands, technical research projects on upland land management and soil conservation will continue, but there will be greater emphasis on economic and institutional issues and constraints to the adoption of proven technologies. It will also highlight the importance of cash incomes and food security for those working steep lands. More projects will involve research on integrated management of water and soil resources at the catchment level, and will be designed to enable 'scaling out'.
- Some work on **soil, water and crop contamination** will continue although with decreased emphasis. Priority will be given to research on management of wastes arising from agricultural industries including intensive livestock operations, and to reclamation of wastewaters for agricultural production. For protection of water quality, ACIAR will emphasise an integrated catchment approach, with particular attention on maintaining profitable agricultural activities that also protect off-site surface water and groundwater quality. Other research will involve production systems and integrated pest management strategies that minimise the use of chemical pesticides, and postharvest decontamination systems.

Agricultural policy and agricultural systems research

ACIAR supports research to identify environments suited to the uptake of agricultural technologies, and targets areas deemed feasible for policy change. There are three broad emphases for agricultural policy work:

- **agricultural industry and trade policy**, with commodity- or industry-specific studies to assess policy requirements for improved access for smallholders into developing markets. This includes local and national structural adjustment (rural transformation) to support agricultural diversification, including the assessment of policy requirements to achieve production change and meet market requirements
- **natural resource management economic policy**, with a focus on water resources, particularly institutional policies to promote equitable and efficient use of surface water and groundwater resources. Other issues include: management of both community resources and resources under common title or common access, including common grazing lands, rangelands, fishery stocks and forests; research on how to involve resource users and stakeholders in designing and implementing resource management; and use of decision-support tools to assist in the management of shared resources
- **rural development policy**, including analysis of structural adjustment following trade liberalisation, cooperative arrangements and the role of social capital in successful rural institutions. ACIAR will foster policy research on institutional adjustments that will improve links between farmers and markets, including on marketing, sanitary and phytosanitary harmonisation, development of small to medium enterprises, rural infrastructure and impacts of decentralisation.

The approach to policy research at a higher level is complemented by **agricultural systems work** that emphasises integrated applied economic and biophysical research with a systems (and farmer) orientation at local and regional levels. There are three particular areas of emphasis:

- **Making existing extension systems more effective** includes the study of extension systems, and documenting and trialling new methodologies, both at the district and system-wide levels.
- **Research into marketing systems** is also important, to seek efficiencies post farmgate and/or link on-farm production decisions to subsequent post-farmgate activities.
- **Systems modelling for variable environments** involves an essential thorough understanding of the climatic, biophysical and socioeconomic conditions that make up farming systems. Specific priorities for research involving systems modelling include: enhancement of components of the models to specific developing-country farming systems; development of information in a form that encourages dialogue between farmers and extension or research workers; consideration of the

long-term effects of changes (e.g. climate change) to farming systems; and consideration of enterprise mixes (e.g. crops and livestock) to reduce risk to income, assets and food security, improve income generation and support sustainability of the natural resources.

Gender

Women have a central role in smallholder agriculture in developing countries, particularly in areas such as vegetable, poultry and aquaculture production, and in marketing of agricultural products. With more men migrating seasonally or permanently to cities in search of work, and with the impacts of HIV/AIDS, there is an increasing number of farming households with women at the head. ACIAR recognises the role of women in sustainable rural development, and the Australian aid program's statement on gender (Gender Equality in Australia's Aid Program, AusAID, 2007 <http://www.ausaid.gov.au/publications/pubout.cfm?ID=39_3102_3439_6270_8533>) acknowledges that the employment of women has often done more to improve global economic growth than capital investments or productivity improvements.

ACIAR projects recognise the importance of integrating gender issues in the design of all its research projects, as well as commissioning a number of projects that specifically examine ways in which to enhance the role of women in agricultural production and marketing. For example, a recently concluded project, PLIA/2007/039 'Impact of migration and off-farm employment on roles of women and appropriate technologies in Asian and mixed farming systems', found that training of women led to yield increases of 15–20% in the Philippines and a major reduction of farm input costs in Vietnam, resulting in marketable surpluses and increased income. The Autumn 2008 issue of ACIAR's flagship *Partners* magazine highlights a number of other examples where gender issues have been a key focus of ACIAR's programs.

ACIAR also seeks to increase opportunities for women to engage in capacity-building exercises and maximise opportunities for women from developing countries and Australia to participate in ACIAR projects. The John Allwright Fellowship (postgraduate scheme) particularly seeks applications from women, and at present approximately one-third of its active scholarships are held by women.

Agribusiness

ACIAR's Agribusiness program focuses on issues that can improve conditions for smallholders and increase value chain efficiency. Although the program focuses mainly on Indonesia, agribusiness work is a component of other discipline programs in most of ACIAR's South-East Asian partner countries. In Indonesia it provides cross-cutting engagement with livestock production, fisheries and aquaculture, crops and forestry products. Research supported by the program has a market-driven focus, and researchers gauge the impacts of technical and regulatory

interventions throughout the value chain. The agribusiness program will contribute to:

- building farmer groups and supply chains to increase market performance through improved engagement between participants in the chain, including approaches to better use market intelligence to improve performance
- implementing market-focused systems to improve competitiveness, including areas such as traceability, food safety and other market-required systems and certification
- delivering consistent, quality product to improve competitiveness, in tandem with productivity improvements.

Appendix 1c: Country focus for ACIAR's R&D programs in 2008–09

Crops cluster

- **Crop Improvement and Management (CIM)** research is in China and India where many of the production constraints are similar to those in Australia; and in Cambodia, Laos, East Timor, Iraq and Afghanistan where introduction of improved staple crops can assist food security and technical cooperation is critical to improved local capacity, and through collaboration with several CGIAR centres.
- **Crop Protection (CP)** research is particularly in countries neighbouring Australia, such as Papua New Guinea, Pacific islands countries (through the ACIAR Horticulture program), Indonesia and Vietnam, where crop losses due to pests and diseases constrain farm incomes, and where there are mutual biosecurity concerns.
- **Horticulture (HORT)** research is in the Philippines and Vietnam (through the ACIAR Crop Protection program) where market access and quality are of high priority; and in the Pacific islands countries, Pakistan and Cambodia where improving productivity and quality management in horticultural and tree crops represent significant opportunities to lift smallholder incomes.

Livestock and fisheries cluster

- Research on **Livestock Production Systems (LPS)** focuses on ruminant nutrition and husbandry, particularly for the dairy industry, and on optimising crop livestock systems. Countries involved include Indonesia, Vietnam, Cambodia, Pakistan, the Republic of South Africa and Tibet Autonomous Region (PR China).
- The **Animal Health (AH)** program primarily works in Indonesia, Laos and Cambodia, with a focus on trans-boundary and zoonotic diseases that affect productivity and marketability. Papua New Guinea is another targeted country for research investment.
- The **Fisheries (FIS)** program has a geographic focus on island countries such as Papua New Guinea, the Pacific islands countries, Indonesia and the Philippines, as well as selectively complementing other donor programs in Mekong countries such as Laos and Vietnam.

Natural resource management cluster

- The **Forestry (FST)** program seeks to work in countries where there is a significant competitive advantage with respect to forestry—such as suitable climate and land, and people skilled in growing trees. These include Papua New Guinea, some Pacific islands countries, Indonesia, Vietnam and Laos.
- The **Land and Water Resources (LWR)** program emphasises agricultural land and water management

in China, India and Pakistan. In the more marginal regions of Bangladesh and India, emphasis will be on improving livelihoods through raising yields and the development of labour-efficient production systems.

- The **Soil Management and Crop Nutrition (SMCN)** program focuses on wetter countries, including Papua New Guinea, the Philippines, Vietnam, Burma and South Africa, where researchers confront issues such as soil management and fertility as well as seasonal water scarcity. Another focus is post-tsunami land rehabilitation in Indonesia.

Economics and policy cluster

- The **Agricultural Development Policy (ADP)** program research is focused on China, Indonesia and India.
- The **Policy Linkages and Impact Assessment (PLIA)** programs make smaller, strategic investments to improve interdisciplinary linkages between economics and biophysical agricultural R&D in developing countries and Australia. The current focus is on Papua New Guinea, Pacific islands countries and the Philippines.
- The **Agricultural Systems Management (ASEM)** program particularly addresses problems in Papua New Guinea, the Philippines, Laos and Cambodia.
- **Agribusiness (AGB)** development is of key importance in several countries. Within Indonesia and Vietnam it is managed by the ACIAR Agribusiness program, while a range of programs manage agribusiness projects in other countries.

Summary: Country by research program matrix for new project development

Country/ region	Economics and social sciences cluster			Crops cluster			Natural resource management cluster			Livestock cluster		
	ADP	ASEM/ AGB	PLIA	CIM	CP	HORT	LWR	SMCN	FST	AH	LPS	FIS
PNG		Developing new projects	Special initiatives only		Developing new projects			Developing new projects	Developing new projects	Special initiatives only		Developing new projects
Pacific			Special initiatives only		Developing new projects	Developing new projects			Developing new projects		Special initiatives only	Developing new projects
Indonesia	Developing new projects	Agribusiness program (Indonesia and Vietnam)			Developing new projects			Special initiatives only	Developing new projects	Developing new projects	Developing new projects	Developing new projects
The Philippines		Developing new projects	Special initiatives only			Developing new projects		Developing new projects				Developing new projects
East Timor				Developing new projects						Special initiatives only	Developing new projects	
Vietnam	Developing new projects	Agribusiness program (Indonesia and Vietnam)			Developing new projects			Developing new projects	Developing new projects		Developing new projects	Developing new projects
Cambodia		Developing new projects		Developing new projects		Developing new projects				Developing new projects		
Laos		Developing new projects		Developing new projects					Developing new projects	Developing new projects		Developing new projects
Thailand				Special initiatives only	Special initiatives only					Special initiatives only		
Burma								Special initiatives only				
China	Developing new projects		Special initiatives only	Developing new projects			Developing new projects				Special initiatives only	
DPR Korea							Special initiatives only					
India	Developing new projects			Developing new projects			Developing new projects					
Pakistan						Developing new projects	Developing new projects					
Bangladesh				Developing new projects			Developing new projects					
Other South Asia/Iraq				Special initiatives only		Special initiatives only						
South Africa											Developing new projects	

- Special initiatives only*
- Developing new projects*
- Agribusiness program (Indonesia and Vietnam)*

Appendix 1d: Balancing ACIAR's project portfolio: project design and delivery

ACIAR projects aim to deliver technical interventions and solutions to the problems that constrain more productive and sustainable agricultural systems. In the recent past ACIAR has introduced changes to project design, development and evaluation to give more emphasis to adoption pathways and the expected impact of proposed research, development and extension studies. The goal is to enhance adoption of project results by the targeted beneficiaries or end users (smallholder farmers, fisherfolk, industry, natural resource managers and policymakers).

All project proposals should take into account the Project Development Guidelines, available on the ACIAR website, and relevant country priorities outlined in this plan. Early consultation with the relevant ACIAR Research Program Manager is strongly encouraged. The main initiatives are:

Increased emphasis on delivering benefits through projects that directly target end users

This plan outlines indicative priorities by program and country. These priorities have been drawn up to focus projects on specific topic areas. ACIAR expects this focus to result in more projects that take research outputs through to a pilot extension phase in which end users are directly involved. To support this change, ACIAR is developing more partnerships that involve private sector extension agencies, the commercial sector, NGOs and government extension agencies as well as public sector researchers (see Appendix 1e).

In assessing new proposals, ACIAR will consider whether the proposed research is an appropriate intervention to improve livelihoods and stimulate economic growth. More biophysical and socioeconomic benchmarking will be conducted, often involving a suite of scoping studies commissioned by ACIAR as 'small research activities'.

Consideration of the expected time to impact for new project proposals

ACIAR has defined the following categories of 'expected time for the project results to impact on groups outside those directly involved in the research':

Category 1 (near-term impact): significant community-level impacts are likely within 5 years of project completion

ACIAR aims to invest 40% of new project expenditure in projects that should in the near term achieve significant impacts for communities outside those directly involved in the project R&D activities. This category may include projects where: the technical concepts are already well proven in the particular context and the focus is on facilitation of adoption; there is good local capacity and strong demand-pull for the project outputs from the local end-user groups; and markets are well defined and accessible. It may also focus on areas where strong linkages with private enterprises, farmer groups and senior policymakers, or with

other large-scale development activities, will assist adoption and sustainability beyond project life.

Category 2 (medium-term impact): significant community-level impacts are likely within 5–10 years of project completion

A further 40% of ACIAR's new project expenditure is aimed at projects designed to have impacts in the medium term. This category may include projects that involve adaptation of proven technical concepts to a local situation or enhancement of local capacity to deal with the issue under study. It may involve the next users of the project outputs, intermediaries such as extension workers or local/regional policymakers rather than the ultimate end users, or be appropriate where further investment is likely to be required to facilitate large-scale adoption of outputs.

Category 3 (long-term impact): achievement of significant community-level impacts is likely to take more than 10 years from project completion

The remaining 20% of ACIAR's new project expenditure is aimed at projects of a more strategic nature, where extensive research is required to develop or prove a model or concept. Other scientists are the main user group, local research capacity building is a major aspect of the project, and project outputs are likely to require further refinement and adaptation through several more research cycles before a product is available for testing in the field.

Full details are included in Appendix 1 of ACIAR's Project Development Guidelines, which are located at <<http://www.aciar.gov.au/node/2632>>.

Scoping of relevant R&D activities

In addition to its investments in collaborative R&D projects, ACIAR will commission scoping studies to gain a better understanding of the nature of a research problem and the issues involved in delivering solutions to end users. Scoping studies will aim to identify appropriate R&D interventions and approaches that will set the scene for larger, longer term and sectorally focused investments on a country-by-country basis.

Capturing data on project impacts more broadly and more regularly

A new impact assessment framework (*Measuring the poverty impact of ACIAR projects: a broad framework*, ACIAR Impact Assessment Series Report 19) was developed in 2002. ACIAR promotes this framework for identifying and measuring issues such as attitudinal change and non-market benefits (e.g. better water quality, ecosystem integrity, healthier people, greater sense of empowerment, increased institutional efficiency). In addition, ACIAR will continue to commission studies of adoption of outputs from large projects completed 3–4 years ago, and formal economic impact assessments of selected projects.

Appendix 1e: ACIAR's engagement with non-government and community-based organisations

ACIAR is increasing the emphasis on practical implementation of results from the projects it supports, highlighting adoption pathways and the impact focus of project proposals. To achieve this, a greater proportion of projects will be designed to deliver tangible benefits to end users in the shorter term. We are actively increasing the involvement of development and extension agencies and the private sector in new projects. Projects are divided into three categories (near, medium and long term) based on the expected time to impact (see Appendix 1d).

ACIAR seeks to include non-government organisations (NGOs) and community-based organisations (CBOs) in project activities that:

- foster technology adoption by disseminating to end users appropriate technologies from earlier or current ACIAR-supported projects
- involve an NGO or CBO as a central partner in initial project activities
- use a small contract to meet a specific need for assistance on a particular technology
- involve NGOs/CBOs in communication activities
- involve volunteers, through appropriate agencies, in project activities.

NGO and community-based partners should have an ongoing link to a target community or already be engaged in that community. Projects should link such partners with the Australian and developing-country technology providers. ACIAR's support will focus on projects that pilot new and existing technologies emerging from projects supported by the Centre. NGOs and CBOs will then be in a position to 'scale-up' these technologies to districts, provinces and, where appropriate, other countries.

ACIAR already works with a number of private sector organisations in its projects, including individual Australian or partner-country companies and industry associations. Often these partners can mobilise human and financial resources for project collaboration, assist with the extension process and enable the involvement of an appropriate target audience of farmers. In many developing countries where government extension systems are weak, company involvement is an attractive approach to foster post-project sustainability. Potential advantages for commercial organisations from involvement in ACIAR projects include access to new technologies and international research expertise; development or evaluation of new products and services and access to 'new' markets for goods and services in demand from farmers and processors (e.g. seeds and fertilisers). Through application of the results of research, companies may achieve greater consistency and quality of raw material supply.

Relationships can range from formal involvement of the company or industry organisation in a project (with appropriate cost-sharing arrangements) or more informal involvement (e.g. working on company field sites, or relationships developed for information sharing and use of project results). ACIAR recognises the importance of intellectual property in particular situations but, to date, has been able to effectively address both the requirements of the commercial partner and the public good needs of investment of aid program funds.

Further details on engaging with ACIAR are available through the ACIAR website under 'Project Development Guidelines'. All project proposals should take into account the project development guidelines, available on the website, and relevant country priorities outlined in this plan. Early consultation with the relevant ACIAR Research Program Manager is strongly encouraged.

Appendix 2: Benefits to Australia

ACIAR provides a unique interface between two very important parts of the Australian economic and social environment. It integrates foreign aid policy with the Australian innovation system to provide mutual benefits to poorer nations in our region and to Australia.

This unique role is illustrated in the diagram below. ACIAR provides funding to support research activities that impinge on both areas to give a unique set of mutual benefits from both bilateral and multilateral activities.

ACIAR's multilateral funding provides leverage to ensure that much of the vast stock of research undertaken by the Consultative Group on International Agricultural Research (CGIAR) system is focused on Australia's foreign policy priority regions. However, this funding also enables access to this large international network for many Australian scientists who use it to benefit Australia's agriculture, forestry and fisheries sectors.

A recent study (Pearce D, et al. (CIE) 'Benefits to Australia from ACIAR-funded research', ACIAR Impact Assessment Series 39, September 2006) has used ACIAR's comprehensive set of independent impact assessment studies (IAS) to summarise the quantitative impacts of these unique relationships.

Ways in which ACIAR generates benefits to Australia

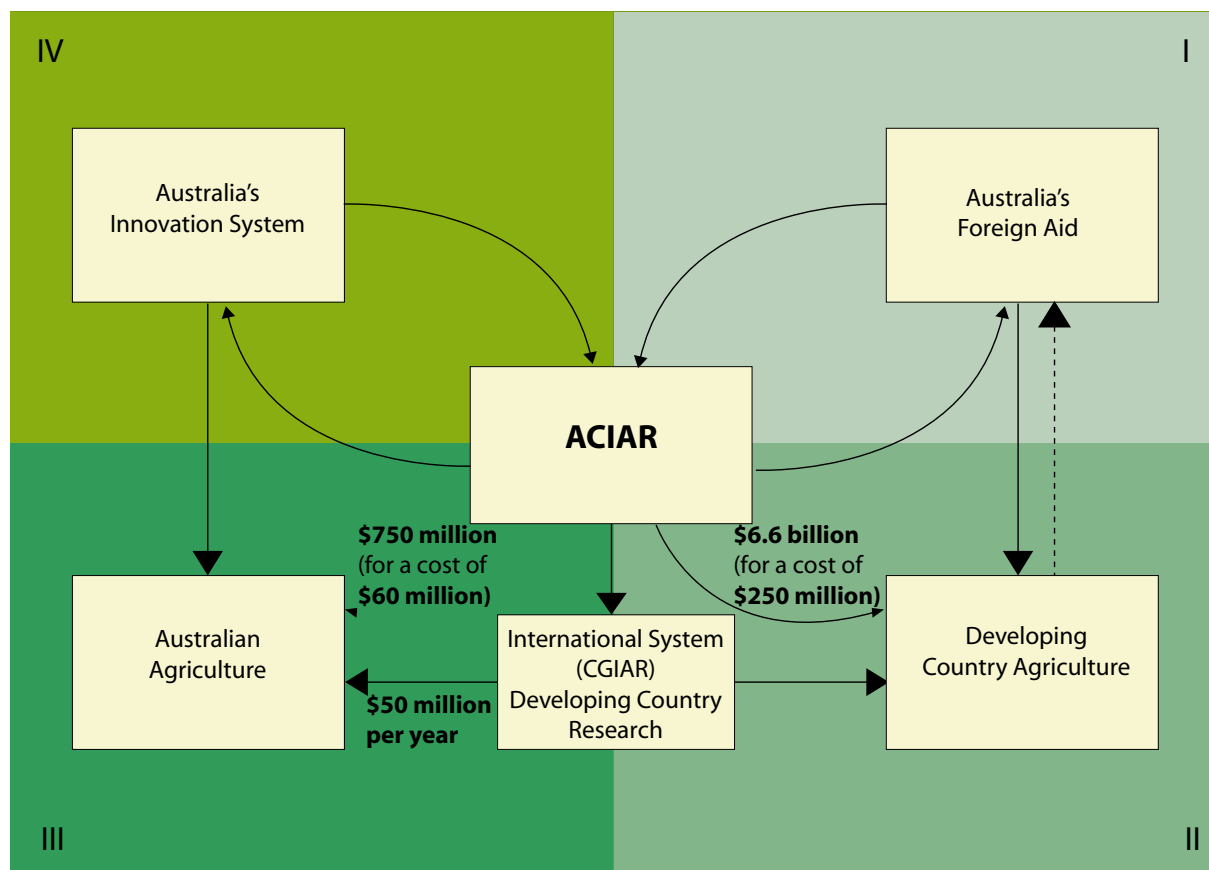
Effectively delivering Australia's international aid

From the impact assessments undertaken to date, ACIAR-partner-funded projects have delivered a total of \$6.6 billion in gross benefits to all partners for a total expenditure of \$250 million (expressed in constant 2004 Australian dollars). As these projects are partnerships, it was estimated that \$3.6 billion of these benefits can be attributed to ACIAR funding (which was \$134 million). This is a very high rate of return, around \$27 for each \$1 invested. It indicates that, even if there were no benefits from the rest of the not-yet-assessed projects, this more than justifies total ACIAR funding since 1982 of around \$1.2 billion (2004 dollars).

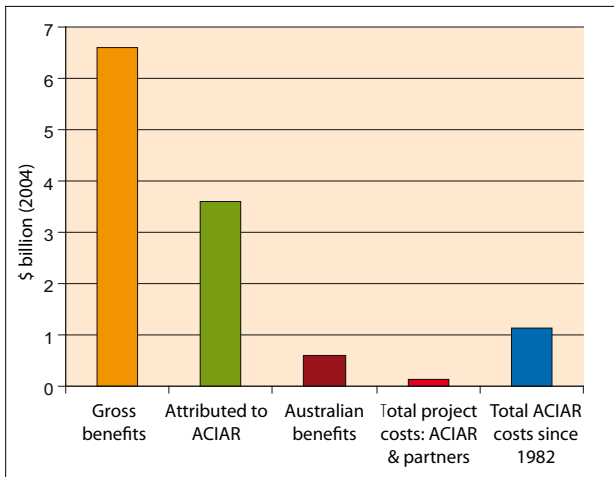
As well as these quantified benefits, ACIAR's activities are extremely popular in partner developing countries, enhancing Australia's recognition in the region.

Interacting with Australia's innovation system

ACIAR commissions research providers from Australia (see the map at the end of this Appendix for a comprehensive list) as well as internationally, and helps generate a number of key interactions with Australia's overall innovation



ACIAR's unique interface between foreign policy and Australia's innovation system to deliver mutual benefits to both developing countries and Australia



Returns to ACIAR & partner investments for 8% of projects (\$A billion 2004)

system. These interactions enhance the ways in which overall agricultural research delivers benefits to Australian agriculture, including:

- leveraging funding into areas of importance for Australian agriculture
- providing access to a broader pool of researchers for problems of interest, that is to international expertise and environments to work in
- increasing the overall research base for agricultural issues of interest to Australia
- contributing to the overall stock of knowledge in an international context and thus helping to identify and discriminate between promising areas for research and 'dry holes'.

Significant quantifiable benefits to Australian agriculture from ACIAR's bilateral program

Impact assessment evidence suggests that past ACIAR-funded projects have delivered significant benefits to Australian agriculture, forestry and fisheries sectors. Of the total gross impact benefits of \$6.6 billion, \$748 million has accrued to Australia. This more than covers the full cost to ACIAR of those projects, which amounted to around \$60 million in present value terms.

These quantified benefits arise in four main categories (see the chart below):

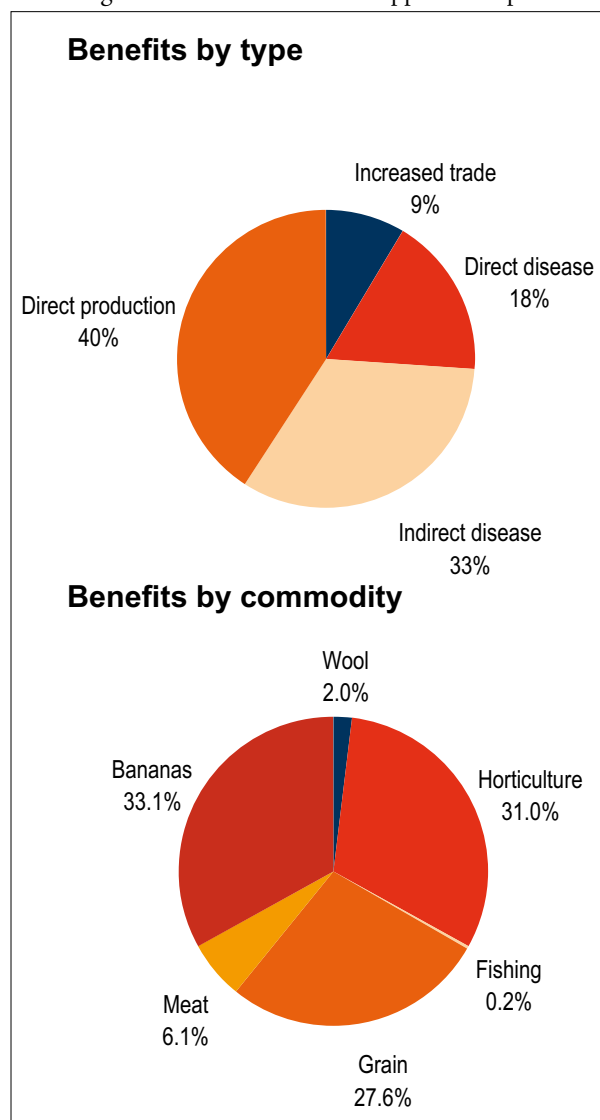
- **Direct production benefits** (44% of the total) arising through research findings that directly improve the productivity of Australian agriculture. Examples include: postharvest treatment of tropical fruit, especially mangoes; conservation tillage in dryland farming systems; improved drying of high-moisture grains; and improved nutrition and quality of canola.
- **Indirect protection from disease or pest incursion** (35% of the total) arising through research findings that lower the chance of certain diseases or pests ever entering Australia. Examples are: biological control of banana skipper in Papua New Guinea and improved

methods for detection and control of bee mites.

- **Direct protection from disease or pest incursion** (12% of the total) arising from research findings that allow more effective quarantine or control of disease or pest incursions. Examples include: improved management of foot-and-mouth disease (FMD); reduced fish losses from epizootic ulcerative syndrome; tick-borne disease control in cattle; and pest control in stored grains.
- **Increased trade benefits** (9% of the total) arising through research that increases the value of Australian exports or access to markets. For example, heat systems for disinfestations in tropical fruits; fruit fly research for market access; wool production and marketing in China; and diagnosis and control of bluetongue disease in small ruminants.

A wide range of industries in Australia have benefited from ACIAR's research (see chart below):

- The banana industry received 33% of the total benefits. This is due to the very large benefit arising from the biological control of banana skipper in Papua New



Impact of benefits by type of benefit and Australian industry

Guinea, which has reduced significantly the risk of incursion into Australia.

- Horticulture (including tropical fruits) received 31% of the total benefits.
- The grains industry received 28% of the total benefits.
- Meat industries (including grazing) received 6% of the total benefits.
- The wool industry received 2% of the total benefits.
- The fishing industry received less than 1% of the total benefits.

Significant quantifiable benefits to Australian agriculture from ACIAR's multilateral program

As part of the international system of agricultural research, ACIAR's funding and interactions with multilateral research organisations also help to contribute benefits to Australian agriculture. ACIAR impact assessments have shown that these benefits total approximately \$55 million per year (in 2004 Australian dollars) for a sample of the research activities at four of the 14–15 international agencies (see table below).

Of course, these benefits cannot all be attributed to ACIAR's funds, but ACIAR's interaction with these agencies is significant. They provide Australian access to and leverage for this research.

Benefits to Australia from research by international agencies

International agency	Commodity	Average annual benefit \$ million (2004)
ICRISAT	Sorghum	2.0
	Chickpeas	0.7
ICARDA	Barley	3.0
	Durum	-1.1
	Chickpeas	1.5
	Faba beans	7.6
CIMMYT	Lentils	6.1
	Wheat	33.4
CABI	Research cost saving	1.8
Total		55.0

Examples of current projects with expected Australian benefits

The above discussion has focused on the quantified returns to finished research activities funded by ACIAR and its partners. Australian or mutual benefits are an important selection criterion for all ACIAR-funded projects. Most projects include research that is expected to generate benefits to Australian agriculture.

Below is an illustrative list of a small sample of these projects which are still being undertaken or are in their final stages.

Better quality mangoes through better plant nutrition management for disease control and improved postharvest fruit life. Earlier ACIAR projects significantly increased

the understanding of mango physiology, especially the relationship between plant nutrition and disease management but also the fruit storability and therefore quality for consumers. The latter is especially important for improved access to export markets but also for improved quality for domestic consumers, given the long distances mangoes are transported within Australia. A set of four projects is making use of the earlier research outcomes to develop simple management options and technologies for application in a range of conditions. For Australia significant adoption of the integrated package is expected during the next few years, with substantial benefits to Australian mango growers and consumers. These projects are: HORT/2005/157 'Optimising mango supply chains for more profitable horticultural agri-enterprises in Pakistan and Australia'; HORT/2005/153 'Development of integrated crop management practices to increase sustainable yield and quality of mangoes in Pakistan and Australia'; HORT/2003/071 'Integrated pest management and supply chain improvement for mangoes in the Philippines and Australia'; and SMAR/2007/193 'Quality management to enhance effective supply chains for mangoes and rambutans in Nusa Tenggara Barat (NTB), Indonesia'.

Supporting stronger trade relations between India and Australia

An important strategy of ACIAR's Agricultural Development Policy (ADP) program is to support and encourage the 'twin-pillars approach to sustainable economic development'². ACIAR is funding projects in several countries which are providing a rigorous research base for development of understanding and evidence of the gains from undertaking domestic economic reform to complement trade liberalisation at the border. Two current projects in India are good examples: ADP/2002/089 'Agricultural trade liberalisation and domestic market reforms in Indian agriculture' and ADP/2007/062 'Facilitating agricultural sector reforms in India: An assessment of regulatory and competition policy requirements'. The former is nearing completion and has undertaken analysis of the gains to India from this twin-pillar approach. These results are being used to effectively influence the policy debate. The latter project is about to commence and will use Australia's extensive experience in competition policy development and implementation to support continued policy reform in India. Benefits to Australia will include improved trading environments with one of the large and rapidly growing world markets, and enhanced collaborative links between policy researchers and policy advisors in both countries. This will support more constructive and effective relationships between the two countries in years to come.

Improved seasonal climate forecasting to enhance farmer decision-making and profitability

Rainfed agriculture in eastern Australia is greatly affected by the El Niño Southern Oscillation (ENSO). Areas affected by ENSO suffer from increased variability, but farmers are now gaining access to the emerging science of seasonal climate forecasting (SCF). The project ASEM/2003/009 'Bridging the gap

² See 'The Hon. Simon Crean, MP, Minister for Trade, Australia and India building a stronger relationship', Press Release, 20 January, 2008.

between seasonal climate forecasts and decision-makers in agriculture' is using these latest developments to develop robust ways for decision-makers to integrate skilful but uncertain forecasts into their long-term risk management. The end result will be reduced seasonal volatility and increased incomes for rural communities in Australia and the Philippines.

New disease-resistant canola varieties with higher yields in drier environments Australia stands to benefit significantly from this project through sharing of a wide range of diverse plant material which originates in India and China and has not been previously available in Australia. This material is showing very good potential to add significantly to the disease resistance of Australian canola varieties and also to provide varieties with higher yields in drier conditions. The Australian research group benefited from the extensive staff resources available to the collaborating partners, who assisted in labour-intensive work that brought about excellent progress in developing hybrid protocols for canola. This work has potential to yield additional gains from hybrid vigour. The good potential for Australian benefits from this research is further demonstrated by significant co-funding by the Australian industry through the Grains Research and Development Corporation (GRDC). The project is CIM/1999/072 'Oilseed *Brassica* improvement in China, India and Australia'.

Improved fruit fly management and incursion risk reduction Fruit fly understanding and control has been a major focus for ACIAR and its partners, with significant gains already achieved and three current projects that continue to address this important area. They will generate future improvements in management options for Australian farmers and also reduce the risk of outside incursion through better understanding of damaging species, better control in partner countries and improved quarantine measures. These projects are CP/1998/005 'Managing pest fruit flies to increase production of fruit and vegetable crops in Vietnam', CP/2003/042 'Fruit fly management in Papua New Guinea' and CP/2003/036 'Managing pest fruit flies to enhance quarantine services and upgrade fruit and vegetable production in Indonesia'.

Teak to provide diversity for northern Australia's high-quality timber industry High-value plantation timbers are an important area of land-use diversity in northern Australia and teak is important internationally as a plantation species. To successfully adapt this species to Australian conditions, this project will identify optimal silvicultural practices. In addition, it will investigate in detail the timber properties of young teak so that shorter rotation lengths can be adopted and improvements in profitability achieved. Significant Australian industry co-funding is being contributed due to the strong industry interest in this species. The project is FST/2007/020 'Improving silvicultural and economic outcomes for community timber plantations in Solomon Islands by interplanting with teak (*Flueggea flexuosa*) and other Pacific agroforestry species'.

Improved sustainability of marine fisheries through regional management agreements with Indonesia Building on 15 years of relationships developed through well-regarded research collaboration, a new project will finalise the development of new stock assessment frameworks to support regional management agreement negotiations between Indonesian, Australian and other governments in the region. The work will target a number of commercial fisheries of strong common interest, including tuna, tuna baitfish, snappers, and sharks and rays. It will also include the control and management of illegal, unregulated and unreported (IUU) fishing. The new project is FIS/2006/142 'New assessment and policy frameworks for Indonesia's marine fisheries, including the control and management of illegal, unregulated and unreported (IUU) fishing'.

New hybrid sugarcane with enhanced disease resistance and higher yields Commercial sugarcane production around the world is currently based on a relatively narrow set of plant material which is cloned for production. China has, over the past 20 years, established an extensive collection of diverse sugarcane-related germplasm from the wild, especially from south-western China. This ACIAR project will facilitate access to this material for the Australian sugar industry through research collaboration. The research will use DNA markers to assess genetic diversity and relationships among clones in germplasm collections in China and Australia, and with clones used in core breeding programs in both countries. They will then select a core sample of clones that will most effectively capture the unique genetic variations in the large collections. These will be used as core parent material in the breeding program in Australia (and China). It is expected that this will result in significant advances in sugar quality, disease resistance and better tolerance to drier conditions. The project is CIM/2000/038 'Use and improvement of sugarcane germplasm'.

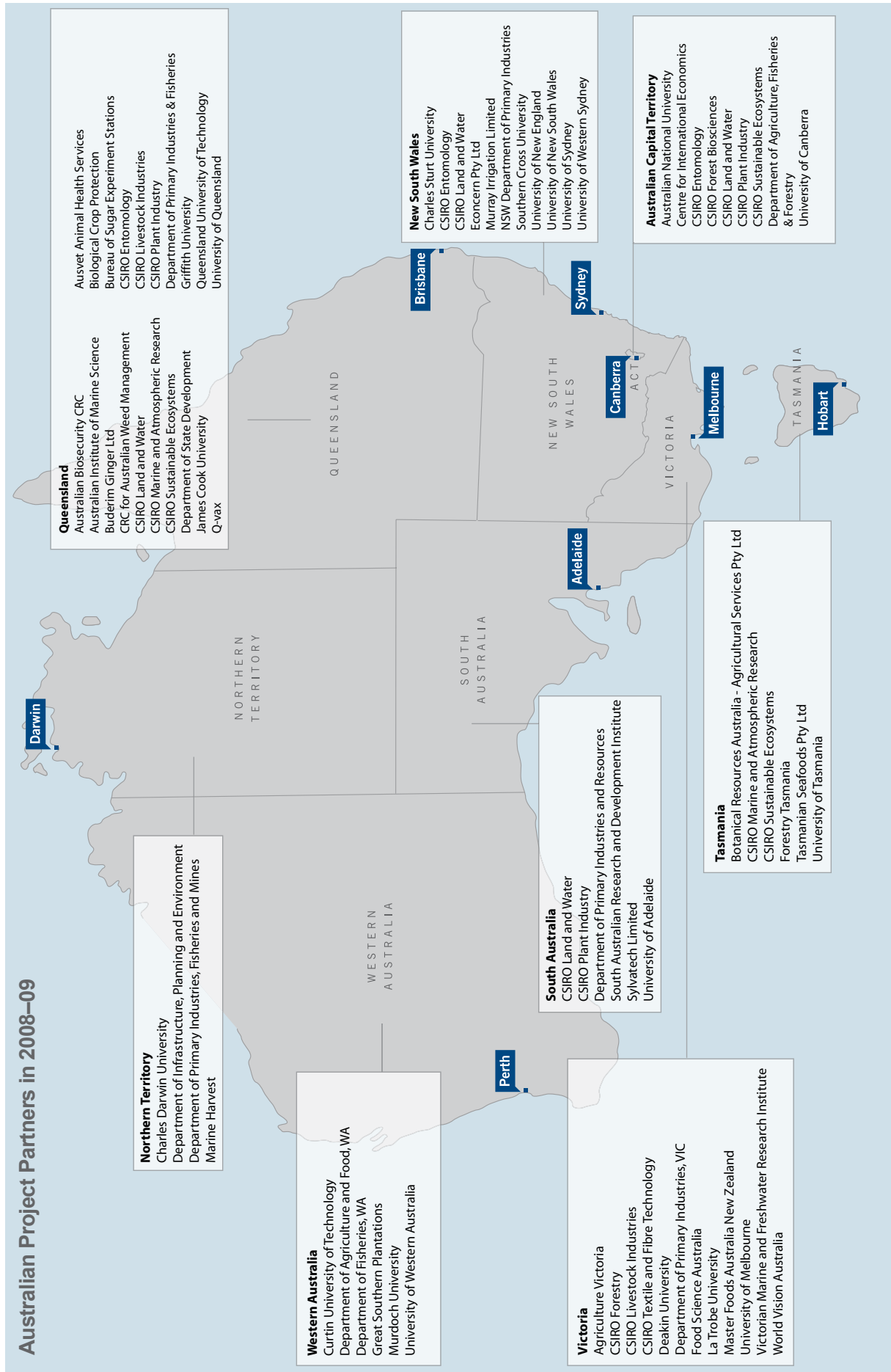
Better biosecurity preparedness for avian influenza in Australia No cases of H5N1 avian influenza (AI) have been reported in the country, but Australia has developed a national biosecurity preparedness plan for this major world threat. This project, through effective collaboration between Australian and Indonesian research groups, is providing important support to this preparedness activity. Working with Indonesian partners it will: assess the breadth and duration of immunity induced by various inactivated AI vaccines; develop reagents for 'DIVA' (differentiation of infected from vaccinated animals) testing; and develop sustainable protocols for investigating apparent vaccine failures for highly pathogenic avian influenza (HPAI). In addition, more effective diagnostic and control strategies in Indonesia will significantly reduce the risk of incursion into Australia. The project is AH/2006/050 'Control and characterisation of highly pathogenic avian influenza strains in poultry in Indonesia'.

Better quality beef for Australia's harsher northern regions Research on the quality of meat from indigenous

South African cattle breeds used by smallholders has shown that, with the same feeding and management, the beef quality was the same as that from imported breeds. Yet these indigenous breeds have improved productivity in harsh breeding and growing environments. These results have had significant implications for the beef industry in harsher areas of Australia's north. Australia has imported genetic material from South African indigenous breeds and is using four-way cross-breeding programs to develop cattle adapted to a range of harsh environments. These are used as stable breeds which can be included in integrated cattle production systems. Finishing these cattle off on high-quality feed provides high-quality meat for export and domestic markets, which has led to considerable productivity gains from the harsher conditions of northern breeding areas. The projects are: LPS/1999/036 'Developing profitable beef business systems for previously disadvantaged farmers in South Africa' and LPS/2005/128 'Developing supply chain partnerships for the emerging beef sector in South Africa'.

Reduced greenhouse gas (GHG) emissions through changed agricultural practices Research being conducted in China and Australia will refine modelling tools to enable more precise prediction of the GHG mitigation benefits achieved through changes to agricultural practices in a range of key Australian rural industries. This will aid the development of technologies that farmers can adopt to reduce these emissions. This research is being co-funded by the Australian Greenhouse Office (now Department of Climate Change), which stands to benefit from enhanced capacity to measure emissions. The project is LWR/2003/039 'Improving the management of water and nitrogen fertiliser for agricultural profitability, water quality and reduced nitrous oxide emissions in China and Australia'.

Australian Project Partners in 2008-09



Appendix 3: Selected world development indicators

	Adult illiteracy % of aged over 15 ¹	Agriculture value-added as % of GDP	GDP USD billion	GDP growth ³ annual %	GDP per capita (ppp US\$) ¹	Human development index, ¹ ranking out of 177 countries	Human poverty index, ¹ ranking out of 103 countries	Internet users 1000s ¹	Agricultural Land as % of land area	Life expectancy at birth years	ODA current USD million	Population in millions ¹	Population (rural) as % of total ²	Population density ¹ people per square km	Public spending on education as % of GDP ¹	Public spending on health as % of GDP ¹	Telephone mainlines per 1000 people ¹	Water (access to) % of population ¹
Papua New Guinea & South Pacific																		
Papua New Guinea	42.7	42	4.9	0.2	2,563	145	90	23	2	59.6	266.1	9.1	86.6	13.2	..	3.0	11	39
Fiji	5.6	16	2.7	1.4	6,049	92	50	77	25	68.3	6.4	0.8	49.2	43.8	6.4	2.9	122	47
Solomon Islands	23.4	..	0.3	-2.4	2,031	129	53	8	4	63.0	198.2	0.5	83.0	17.3	3.3	5.6	16	70
Vanuatu	26.0	15	..	..	3,225	120	56	38	12	69.3	39.5	0.2	76.5	16.4	9.6	3.1	33	60
Samoa	1.4	14	0.4	2.5	6,170	77	..	32	46	70.8	44.0	0.2	77.6	70.6	4.5	4.1	73	88
Tonga	1.1	29	0.2	1.9	8,177	55	..	29	42	72.8	31.8	0.1	76.0	133.9	4.8	5.0	..	100
South-East Asia																		
Indonesia	9.6	12	287.2	2.1	3,843	107	47	73	26	69.7	2,523.5	226.1	51.9	118.7	0.9	1.0	58	77
Vietnam	9.7	21	52.4	5.9	3,071	105	36	129	31	73.7	1,904.9	85.0	73.6	256.3	..	1.5	191	85
The Philippines	7.4	14	99.0	1.6	5,137	90	37	54	41	71.0	561.8	84.6	37.3	282.0	2.7	1.4	41	85
Cambodia	26.4	34	6.2	5.5	2,727	131	85	3	30	58.0	537.8	14.0	80.3	31.5	1.9	1.7	3	41
Lao PDR	31.3	45	2.9	3.8	2,039	130	70	4	8	63.2	295.7	5.7	79.4	24.1	2.3	0.8	13	51
East Timor	49.9	32	0.3	..	..	150	95	..	23	59.7	184.7	1.1	73.5	74.0	..	8.8	..	58
Thailand	7.4	10	176.6	2.7	8,677	78	24	110	36	69.6	-171.1	63.0	31.1	122.8	4.2	2.3	110	99
Burma	10.1	..	..	6.6	1,027	132	52	2	17	60.8	144.7	48.0	69.4	70.9	1.3	0.3	9	78
South Asia & Middle East																		
India	39.0	18	805.7	4.2	3,452	128	62	55	61	63.7	1,724.1	1,134.4	71.3	345.1	3.8	0.9	45	86
Pakistan	50.1	20	110.7	2.5	2,370	136	77	67	35	64.6	1,666.5	158.1	65.2	198.6	2.3	0.4	34	91
Bangladesh	52.5	20	60.0	2.9	2,053	140	93	3	69	63.1	1,320.5	153.3	74.9	1,064.6	2.5	0.9	8	74
Bhutan	53.0	25	0.8	5.6	..	133	86	39	13	64.7	90.0	0.6	88.9	12.8	5.6	3.0	51	62
Afghanistan	..	36	8.0	..	..	..	..	..	58	42.9	..	25.1	77.1	38.5	..	..	..	39
Iraq	..	9	13.0	..	..	..	..	..	23	57.7	..	28.0	33.1	63.9	..	..	..	81
North Asia																		
China	9.1	12	2,234.3	8.8	6,757	81	29	85	59	72.5	1,756.9	1,313.0	59.6	136.8	1.9	1.8	269	77
Southern Africa																		
South Africa	17.6	3	239.5	0.6	11,110	121	55	109	82	50.8	700	47.9	40.7	39.2	5.4	3.5	101	88

¹ United Nations Development Program, Human Development Report 2007–2008 Online <http://hdr.undp.org/en/media/hdr_20072008_en_complete.pdf>

² United Nations Statistics Division Online 2007 <<http://unstats.un.org/unsd/demographic/products/socind/>>

³ The World Bank Group, World Development Indicators Online <<http://devdata.worldbank.org/data-query/>>, selected years: 2002–06, data chosen from most recent year available.

Selected world development indicators: definitions

Adult illiteracy

Calculated as 100 minus the adult literacy rate

GDP (US\$)

Gross domestic product converted to US dollars using the average official exchange rate reported by the International Monetary Fund. An alternative conversion factor is applied if the official exchange rate is judged to diverge by an exceptionally large margin from the rate effectively applied to transactions in foreign currencies and traded products.

GDP annual growth rate

Least squares annual growth rate, calculated from constant price GDP in local currency units

GDP per capita (PPPUS\$)

Gross domestic product (in purchasing power parity terms in US dollars) divided by mid-year population.

In comparing standards of living across countries, economic statistics must be converted to purchasing power parity (PPP) terms to eliminate differences in national price levels. Data for comparison of relative prices is provided by the World Bank for 168 countries based on price data from the last International Comparison Program.

Human development index (HDI)

A composite index measuring average achievement in three basic dimensions of human development—a long and healthy life, knowledge and a decent standard of living

Human poverty index (HPI)

A composite index measuring deprivations in the three basic dimensions captured in the human development index—a long and healthy life, knowledge and a decent standard of living

Internet users

People with access to the worldwide network

Life expectancy at birth

The number of years a newborn infant would live if prevailing patterns of age-specific mortality rates at the time of birth were to stay the same throughout the child's life

Official development assistance (ODA)

Disbursements of loans made on concessional terms (net of repayments of principal), and grants by official agencies of the members of the Development Assistance Committee (DAC), multilateral institutions and non-DAC countries to promote economic development and welfare in countries and territories in Part I of the DAC list of aid recipients. It includes loans with a grant element of at least 25% (calculated at a discount rate of 10%).

Population

Refers to the de facto population in a country, area or region as of 1 July of the year indicated

Public education expenditure

Includes both capital expenditures (spending on construction, renovation, major repairs and purchases of heavy equipment or vehicles) and current expenditures

Public health expenditure

Current and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and non-government organisations) and social (or compulsory) health insurance funds. Together with private health expenditure, it makes up total health expenditure.

Telephone mainlines

Telephone lines connecting a customer's equipment to the public switched telephone network

Water (access to)

The share of the population with reasonable access to any of the following types of water supply for drinking: household connection, public standpipe, borehole, protected dug well, protected spring and rainwater collection. Reasonable access is defined as the availability of at least 20 litres a person per day from a source within 1 kilometre of the user's dwelling.

Appendix 4: Major crop, livestock & fisheries* production indicators by partner country

Papua New Guinea and the South Pacific

Papua New Guinea

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Bananas	870,000	Game meat	330,000	Pelagic marine fish	207
Fruit, fresh	810,000	Pig meat	66,001	Freshwater and diadromous fish	12
Coconuts	650,000	Chicken meat	5,583	Marine fish	10
Sweet potatoes	520,000	Cattle meat	3,498	Demersal marine fish	2
Sugarcane	450,000			Crustaceans	2

Fiji

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Sugarcane	2,980,000	Cow milk	57,000	Marine fish	21
Coconuts	140,000	Chicken meat	12,253	Pelagic marine fish	18
Taro (coco yam)	38,000	Cattle meat	8,332	Molluscs	3
Cassava	33,000	Pig meat	3,938	Demersal marine fish	3
Rice, paddy	15,000	Hen eggs	2,700	Crustaceans	1

Solomon Islands

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Coconuts	276,000	Pig meat	2,320	Pelagic marine fish	24
Sweet potatoes	86,000	Cow milk	1,365	Marine fish	12
Taro (coco yam)	40,000	Cattle meat	740		
Yams	29,000	Hen eggs	480		
Fruit, fresh	19,000	Chicken meat	280		

Vanuatu

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Coconuts	315,000	Cattle meat	3,300	Pelagic marine fish	63
Roots and tubers	42,500	Cow milk	3,000	Crustaceans	30
Bananas	14,300	Pig meat	2,804	Marine fish	2
Vegetables, fresh	10,800	Chicken meat	473		
Fruit, fresh	4,750	Hen eggs	320		

Samoa

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Coconuts	140,000	Pig meat	3,801	Pelagic marine fish	2
Bananas	21,500	Cow milk	1,500	Marine fish	1
Taro (coco yam)	17,000	Cattle meat	1,000	Molluscs	1
Fruit, tropical fresh	9,000	Honey	400	Miscellaneous aquatic animals	1
Pineapples	4,600	Chicken meat	331		

* Includes both capture fisheries and aquaculture production. Source: <<http://www.fao.org/ess/yearbook/>>

Tonga

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Coconuts	58,000	Pig meat	1,496	Pelagic marine fish	1
Pumpkins, squash and gourds	20,000	Cattle meat	327	Marine fish	1
Cassava	9,000	Chicken meat	297		
Sweet potatoes	6,000				
Vegetables, fresh	5,500				

South-East Asia

Indonesia

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Rice, paddy	53,984,590	Chicken meat	1,243,975	Pelagic marine fish	2,165
Sugarcane	25,500,000	Hen eggs	876,000	Freshwater and diadromous fish	1,152
Cassava	19,459,400	Pig meat	591,332	Demersal marine fish	881
Coconuts	16,300,000	Cattle meat	395,785	Marine fish	806
Maize	12,013,710			Crustaceans	570

Vietnam

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Rice, paddy	36,341,000	Pig meat	2,098,782	Pelagic marine fish	1,316
Sugarcane	15,000,000	Chicken meat	299,444	Freshwater and diadromous fish	896
Vegetables, fresh	6,600,000	Hen eggs	225,000	Crustaceans	449
Cassava	5,700,000	Cattle meat	120,342	Molluscs	215
Maize	3,500,000	Buffalo meat	103,200	Cephalopods	185

The Philippines

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Sugarcane	31,000,000	Pig meat	1,100,057	Pelagic marine fish	1,570
Rice, paddy	14,800,000	Chicken meat	646,017	Freshwater and diadromous fish	516
Coconuts	14,500,000	Hen eggs	473,000	Demersal marine fish	345
Bananas	5,800,000	Cattle meat	162,284	Crustaceans	131
Maize	5,200,000	Buffalo meat	78,998	Molluscs	85

Cambodia

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Rice, paddy	4,200,000	Pig meat	127,500	Freshwater and diadromous fish	270
Vegetables, fresh	481,250	Cattle meat	61,063	Marine fish	34
Cassava	365,000	Chicken meat	16,500	Crustaceans	18
Maize	258,000	Buffalo meat	13,600	Cephalopods	3
Bananas	148,000	Hen eggs	13,300	Molluscs	2

Lao PDR

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Rice, paddy	2,350,000	Pig meat	27,393	Freshwater and diadromous fish	95
Vegetables, fresh	660,000	Cattle meat	24,643		
Sweet potatoes	248,000	Buffalo meat	20,438		
Maize	210,000	Chicken meat	15,990		
Watermelons	65,000	Hen eggs	12,500		

East Timor

Crops	Total production (Mt)	Livestock	Total production (Mt)
Maize	70,175	Pig meat	10,080
Rice, paddy	65,433	Chicken meat	1,840
Roots and tubers	43,000	Hen eggs	1,600
Cassava	41,525	Cattle meat	1,097
Sweet potatoes	26,000	Buffalo meat	570

Thailand

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Sugarcane	49,572,000	Cattle meat	3,300	Marine fish	924
Rice, paddy	27,000,000	Cow milk	3,000	Pelagic marine fish	884
Cassava	16,938,000	Pig meat	2,804	Crustaceans	558
Maize	4,180,000	Chicken meat	473	Freshwater and diadromous fish	546
Vegetables, fresh	10,800	Hen eggs	320	Demersal marine fish	462

Burma

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Rice, paddy	24,500,000	Cow milk	543,000	Marine fish	1,092
Sugarcane	6,370,000	Chicken meat	307,844	Freshwater and diadromous fish	825
Vegetables, fresh	3,000,000	Pig meat	142,973	Crustaceans	70
Beans, dry	1,550,000	Hen eggs	131,000	Miscellaneous aquatic animals	1
Fruit, fresh	1,150,000	Cattle meat	129,760		

South Asia and the Middle East

India

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Sugarcane	232,320,000	Buffalo milk	50,740,000	Freshwater and diadromous fish	3,092
Rice, paddy	129,000,000	Cow milk	38,500,000	Demersal marine fish	847
Wheat	72,000,000	Hen eggs	2,492,000	Marine fish	786
Vegetables, fresh	35,000,000	Chicken meat	1,901,406	Pelagic marine fish	713
Potatoes	25,000,000	Cattle meat	1,493,008	Crustaceans	636

Pakistan

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Sugarcane	47,244,100	Buffalo milk	19,700,000	Freshwater and diadromous fish	18425
Wheat	21,591,400	Cow milk	9,082,000	Pelagic marine fish	158
Rice, paddy	7,351,000	Goat milk	660,000	Demersal marine fish	150
Maize	2,797,000	Buffalo meat	531,080	Marine fish	40
Potatoes	2,024,300	Cattle meat	470,822	Crustaceans	31

Bangladesh

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Rice, paddy	40,054,000	Goat milk	1,416,000	Freshwater and diadromous fish	1,756
Sugarcane	6,500,000	Cow milk	800,000	Marine fish	234
Potatoes	3,908,000	Cattle meat	179,884	Crustaceans	112
Wheat	1,200,000	Goat meat	137,200		
Vegetables, fresh	942,000	Hen eggs	134,500		

Bhutan

Crops	Total production (Mt)	Livestock	Total production (Mt)
Maize	70,000	Cow milk	41,120
Rice, paddy	45,000	Cattle meat	5,100
Potatoes	40,000	Pig meat	1,098
Oranges	36,000		
Roots and tubers	21,800		

North Asia

China

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Rice, paddy	185,454,000	Cow milk	24,530,080	Freshwater and diadromous fish	19,124
Vegetables, fresh	142,010,000	Hen eggs	24,348,350	Molluscs	11,694
Maize	132,645,000	Eggs, excluding hen	4,326,140	Crustaceans	4,760
Sweet potatoes	107,176,100			Demersal marine fish	4,651
Wheat	96,340,250			Pelagic marine fish	4,079

Southern Africa

South Africa, Republic of

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Sugarcane	21,725,100	Cow milk	2,552,000	Pelagic marine fish	656
Maize	11,996,000	Chicken meat	919,776	Demersal marine fish	200
Wheat	2,034,300	Cattle meat	633,488	Marine fish	11
Potatoes	1,909,060	Hen eggs	340,000	Cephalopods	11
Grapes	1,700,000	Pig meat	140,040	Crustaceans	4

Appendix 5: Major forestry indicators for partner countries

Region/country	Total forest area in 2005 ('000 ha)	Percentage of land area in 2005 (%)	Forest plantations in 2005 ('000 ha)	Annual rate of change 2000–05 (%)
Papua New Guinea and the South Pacific				
Papua New Guinea	29,437	65	92	-0.5
Fiji	1,000	54.7	101	0
Solomon Islands	2,172	77.6	Not available	-1.7
Vanuatu	440	36.1	Not available	0
Samoa	171	60.4	32	0
Tonga	4	5	Not specified	0
Kiribati	2	30	Not available	0
South-East Asia				
Indonesia	104,986	58	3,399	-2.0
Vietnam	12,931	39.7	2,695	2.0
The Philippines	7,162	24	620	-2.1
Cambodia	10,447	59.2	59	-2.0
Lao PDR	16,142	69.9	224	-0.5
East Timor	798	53.7	43	-1.3
Thailand	14,520	28.4	3,099	-0.4
Burma	32,222	49.0	849	-1.4
South Asia				
India	67,701	22.8	3,226	Not specified
Pakistan	2,361	3	318	-2.1
Bangladesh	871	6.7	279	-0.3
Nepal	3,636	25.4	53	-1.4
Sri Lanka	1,933	29.9	0	-1.5
Bhutan	3,195	68	2	0.3
Afghanistan	867	1.3	Not available	-3.1
North Asia				
China	197,290	21.2	31,369	2.2
Southern Africa				
Southern Africa	9,203	7.6	1,426	0

Source: Food and Agriculture Organization of the United Nations, 2005. *Global Forest Resources Assessment 2005: Progress towards sustainable forest management*, FAO Forestry Paper 147

Appendix 6: Acronyms and abbreviations

ACIAR	Australian Centre for International Agricultural Research	FST	Forestry
ADP	Agricultural Development Policy	GDP	gross domestic product
AGB	Agribusiness	GHG	greenhouse gas
AH	Animal Health	HORT	Horticulture
AI	avian influenza	HPAI	highly pathogenic avian influenza
AIPRD	Australia-Indonesia Partnership for Reconstruction and Development	IARCS	International Agricultural Research Centres
AISRF	Australia-India Strategic Research Fund	ICAR	Indian Council for Agricultural Research
AOP	Annual Operational Plan	ICARDA	International Centre for Agricultural Research in the Dry Areas (Syria)
APAARI	Asia-Pacific Association of Agricultural Research Institutes	ICRAF	World Agroforestry Centre (Kenya)
ASEM	Agricultural Systems Economics	ICRISAT	International Crop Research Institute for the Semi-arid Tropics (India)
ASLP	Australia-Pakistan Agriculture Sector Linkages Program	IDM	integrated disease management
ATSE	Academy of Technological Sciences and Engineering (Australia)	IFPRI	International Food Policy Research Institute (USA)
AusAID	Australian Agency for International Development	IITA	International Institute of Tropical Agriculture
AVRDC	Asian Vegetable Research and Development Institute (Taiwan)	ILRI	International Livestock Research Institute (Kenya)
CABI	Centre for Agriculture and Biosciences International (UK)	INIBAP	International Network for the Improvement of Banana and Plantain
CARD	Capacity Building for Agriculture and Rural Development (Vietnam)	IPGRI	International Plant Genetic Resources Institute (now Bioversity International)
CARDI	Cambodian Agricultural R&D Institute	IPM	integrated pest management
CARF	Cambodian Agricultural Research Fund	IRRI	International Rice Research Institute (the Philippines)
CBO	community-based organisation	IUU	illegal unregulated unreported (fishing)
CGIAR	Consultative Group on International Agricultural Research	IWMI	International Water Management Institute (Sri Lanka)
CIAT	International Centre for Tropical Agriculture (Colombia)	LARF	Lao Agricultural Research Fund
CIFOR	Centre for International Forestry Research (Indonesia)	LPS	Livestock Production Systems
CIM	Crop Improvement and Management	LWR	Land and Water Resources
CIMMYT	International Maize and Wheat Improvement Centre (Mexico)	NARS	National Agricultural Research System
CIP	International Potato Centre (Peru)	NGO	non-government organisation
CP	Crop Protection	ODA	Official Development Assistance
CSF	classical swine fever	OIE	World Organisation for Animal Health
DAFF	Department of Agriculture, Forestry and Fisheries	PIC	Pacific islands countries
DEST	Department of Education Science and Training	PLIA	Policy Linkages and Impact Assessment
DFAT	Department of Foreign Affairs and Trade	PNG	Papua New Guinea
DPRK	Democratic People's Republic of Korea	R&D	research and development
DIVA	differentiation of infected from vaccinated animals	RSA	Republic of South Africa
ENSO	El Niño Southern Oscillation	SADI	Smallholder Agribusiness Development Initiative (Indonesia)
FAO	Food and Agriculture Organization	SMAR	Support for Market-Driven Adaptive Research
FIS	Fisheries	SMCN	Soil Management and Crop Nutrition
FMD	foot-and-mouth disease	SPC	Secretariat of the Pacific Community
		TWVC	The World Vegetable Center (formerly AVRDC)
		USP	University of the South Pacific
		WTO	World Trade Organization