

# Appendices

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# Appendix 1a: ACIAR's sectoral strategies for 2007–08

## Field crops

ACIAR targets problems of the major field (broadacre) crops that can have either genetic or agronomic solutions. 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 the Asia and the Pacific region. 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; utilise 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 utilisation 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

- use of break crops and natural soil bio-fumigants
- testing of promising bio-fertilisers.

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. The above applications-oriented work is supported by longer-term research on **manipulating the soil/plant interface** to enhance and predict soil biological function as 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 runoff 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 the 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 preharvest and postharvest losses of fruit and vegetable crops. The ACIAR horticulture program will increasingly focus on a complete **supply chain approach** to crop production. This approach will aim to identify and address multiple constraints to individual horticultural industry development which 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 work that integrates technology for fruit production systems. There is 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 both cash incomes and improvements to nutrition in relatively short time frames. Vegetables such as sweet potato and other root crops are major staples for PNG and the Pacific, 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 in 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 three focus areas: a systems approach to improving preharvest crop productivity including integrated management of pests and diseases; biological control, use of environmentally friendly approaches to pest, disease and weed control (including use of soft chemicals and bio-control 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 the 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 or yield.

### Crop pest and disease management

ACIAR emphasises sustainable management of pests in crops where losses are significant and for which standard chemical solutions are limited in effectiveness, environmentally unsuitable or uneconomic for developing-country smallholders. Recognising that one of the constraints to adoption of IPM is the complexity of the approach and the high level of training needed for farmers, better methods of information dissemination will be supported. ACIAR will focus collaborative **bio-control** research projects in South-East Asia, Papua New Guinea and the South Pacific as many pests are not native to the region and 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 on-going control. For some pests and environments, bio-control 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) to 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.

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

- **Transboundary diseases** not present in Australia, with concerns being avian influenza, classical swine fever and foot-and-mouth disease in 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, and 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 will concentrate on limiting the transmission pathway from animals to humans.
- **Diseases affecting production** through impacts on

mortality, reduced growth rates or production. These constrain other inputs that are required to develop 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 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 and 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 utilise 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 and 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 of these situations, social and economic issues play a very important part in whether such options are appropriate.

**Optimising crop–livestock systems.** Most livestock (small and large ruminants, pigs and poultry) are integral components of complex crop–livestock systems. Crops provide a significant proportion of the feed for these livestock as grains and tubers, stover, green forage, by-products from processing and from the 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 a necessary ingredient for determining intervention points and the development of appropriate technologies for smallholder farmers. High priority for future work includes 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 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 utilisation and quality, and changes in the cropping systems to include higher quality feeds and supplements. Integrated approaches, involving socio-economics, 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 a priority.

**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 with appropriate housing and nutrition is critical as smallholders move from producing these livestock solely for household purposes to entering 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 the 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 timeframes for development of stock with superior traits and subsequent transfer of those traits to the smallholder community, and because 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. In the case of PNG and Indonesia, Australia shares international responsibilities 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, this remains an area of active involvement for ACIAR.

Research areas of emphasis include:

- assessments 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)
- Preharvest and postharvest interventions that improve **utilisation 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 they are a constraint to sustainable and profitable aquaculture operations
- **improved nutrition**, the better use of on-farm feed sources, and the development of cost-effective feed formulations, with emphasis on the reduced use of

fish products and encouragement of low polluting formulations, along with better feeding strategies

- the **diagnosis, control and management of aquatic diseases** as major threats to the long-term viability of intensive aquaculture. A particular emphasis is on shrimp disease management in smallholder systems and on 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 PNG 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 Island nations and indigenous communities in northern Australia
- **Reduction of adverse environmental impacts** of and on aquaculture.

## Forestry

The existing industry in some developing countries is based on the unsustainable harvesting of primary forests, involving rapid depletion of resources, environmental degradation and leading to an imminent major decline in economic returns. There is potential, however, for forestry to be the basis of new industries, supplying wood and non-timber forest products to international markets and yielding major inputs to 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 thrusts 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** for developing countries and deployment of improved germplasm
- development of more **efficient harvesting and processing** approaches and technologies and developing 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 utilisation 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 and provide higher 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 2007–08

## Gender

The White Paper “Australian Aid: promoting growth and Stability” (April 2006) reinforced gender equality is an overarching principle of Australia’s aid program and emphasises the importance of gender equality to growth, governance and stability. Gender equality is integral to all Australian Government aid policies, programs and initiatives. This includes ACIAR, and the White Paper made a commitment that “research programs, including those of ACIAR, will incorporate gender considerations. The publication Gender Equality in Australia’s Aid Program — Why and How (March 2007), reinforces that programs and projects should aim to:

- Improve the economic status of women
- Promote equal participation of women in decision making and leadership
- Improve equitable health and education outcomes
- Ensure gender equality is advanced in regional cooperation efforts.

Women make a substantial contribution to agricultural, forestry and fisheries production efforts in developing countries and are particularly involved in the processing and marketing of agricultural products. ACIAR will ensure that projects aim to improve the economic status of women and include women farmers, processors and marketers in decision-making. We will ensure that there is gender equity in participation in ACIAR-supported training activities and foster increased participation of women in leadership positions in ACIAR projects.

## Quarantine and biosecurity

**Quarantine** is increasingly important for developing countries and Australia for two reasons: national bio-security, 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**: which species occur where and affect which crops, and how 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 **disinfestation technologies**
- Assistance with development of **national quarantine policies**, risk analysis protocols, incursion monitoring systems and incursion 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 preventative animal health control using a mixture of strategic and applied research addressing the total livestock production chain (reinforcing national biosecurity systems) where it will benefit smallholders. Emphasis will be given to projects that address diseases that are exotic (and a perceived threat) to Australia such as foot-and-mouth disease in ruminants and classical swine fever in pigs, as well as 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 supporting Australia’s disease-free status and improving 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 to regional approaches.

## Agricultural sustainability research

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

- **Agricultural water management.** Research is directed to improving irrigation water-use efficiency in arid climates, particularly in well-endowed areas of the Indo-Gangetic Plains, as well as 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, are high priorities 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 rain-fed cropping systems of China, the Mekong Basin, Philippines and India. It ranges from supporting crop diversification and water harvesting in infertile rain-fed areas, to improving sustained production from marginal upland areas and sandy coastal areas. In 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, and the importance of cash incomes and food security of those in 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'.
- **Soil, water and crop contamination.** Work on these 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 to maintaining profitable agricultural activities that also protect off-site surface water and groundwater quality. Research is also supported on production systems and integrated pest management strategies that minimise use of chemical pesticides, and on postharvest decontamination systems.

## Climate change

Climate change issues are addressed in a number of ACIAR's programs, particularly the natural resource management cluster, but also in Crop Improvement and Management, Livestock Production Systems and the Policy programs. Much ACIAR work on pests, diseases and weeds is also highly relevant to climate change adaptation.

The first theme emphasises **scenario prediction** for developing country agriculture under climate change. Several projects focus at least in part on attempting to improve the reliability of seasonal climate forecasts, there is emphasis on how the information can be interpreted in terms of economic risk profiles and used by decision makers and those advising farmers and managing irrigation systems. The second cluster of projects on policy responses and policy impacts for resilience encompasses a diverse group of projects where climate change issues are directly included in project terms of reference but are not the sole focus. These include projects modelling "alternative futures" for agriculture in major developing countries through to projects that explore the hydrological, social and economic

impacts of re-vegetation programs in China. An area of increasing importance in ACIAR's animal health program is trans-boundary disease spread, and climate change is an important influence.

The second theme emphasises **adaptation to climate change**. ACIAR has supported much work in this area, although it is also driven by broader needs to improve crop yields, water use efficiency and foster more profitable farming systems. Some projects have explored the positive economic impact of fostering and maintaining genetic diversity, while a larger number of projects have targeted selection for drought tolerance in specific crops (wheat, maize, sorghum, chickpea, lentils and peanuts in South Asia and wheat and cool season legumes in western China).

Reforestation is widely promoted as a climate change mitigation strategy, as well as providing other environmental services such as watershed protection and amelioration of dryland salinity. However, limited water often constraints tree establishment and production while in other areas trees have been considered as competitors for crop water. In recent years, a number of forestry projects have explored these issues.

A larger number of projects, targeting largely-rainfed areas of Bangladesh, Cambodia and Laos aim to develop crop rotations that make better use of residual moisture, late-season rainfall or limited supplementary irrigation to grow a second crop in situations where land had been fallow for many months. Strategies from these projects will inform approaches to adaptation for climate change in a number of cropping systems. ACIAR has also made a significant contribution to the development of skills in Australia and partner countries in systems modelling for variable environments through models such as APSIM.

The geographical focus for ACIAR's work on field-level water savings has been in the drier regions of China and South Asia. Improving water productivity in cropping systems, through a range of technical interventions such as permanent raised beds, water harvesting, reduced deficit and drip irrigation will become increasingly important. Work on water allocation at the irrigation system level and integrated management at the catchment level has focused on these regions as well as parts of SE Asia, and is highly relevant to a future where climate change is expected to reduce rainfall across much of Asia.

The third theme for current and past ACIAR investment covers **mitigation of the impacts of climate change**. There have been four main areas of emphasis:

- addressing technical and social constraints to foster alternatives to slash and burn cultivation in Thailand, Laos and Indonesia. Slash and burn agriculture has been shown to be a major contributor to greenhouse gas emissions from burning and loss of carbon from agricultural soils;

- several projects on analysis of technical systems and economic incentives for the development of carbon sequestering smallholder forestry and agroforestry systems in Indonesia, along with a single project analysing carbon dynamics in cropping and pasture systems;
- reducing energy use through fostering adoption of conservation farming systems, particularly in China and South Asia. Stubble conservation can have an additional direct and major impact through enhancing sequestration of carbon in agricultural soils;
- reducing greenhouse gas emissions from crop and livestock production. This includes a cluster of projects fostering more targeted nitrogen fertiliser use to reduce emissions of the greenhouse gas, nitrous oxide, as well as a major thematic emphasis on biological nitrogen fixation. The drivers for adoption by smallholder farmers are usually through reduction in input costs rather than environmental enforcement. The second area focuses on a reduction in the emissions of the greenhouse gas, methane from livestock. More efficient feed utilization by livestock together with appropriate stocking rates and husbandry practices can have significant impacts on methane production.

## Agricultural policy and agricultural systems research

ACIAR supports research on the enabling environment for the uptake of agricultural technologies, and targets areas where policy change is deemed to be feasible. 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. Local and national structural adjustment (rural transformation) policy requirements 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 management policy, particularly institutional policies to promote equitable and efficient use of surface water and groundwater resources. Other issues include: management of 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; 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 role of social capital in successful rural institutions. We will foster policy research on institutional adjustments that will improve links between farmers and markets, including research 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.** This includes the study of extension systems, documenting and trialling new methodologies, both at the district and system-wide levels.
- **Research into marketing systems** is also important, to seek efficiencies post-farm gate and/or to link on-farm production decisions to subsequent post-farm gate activities.
- **Systems modelling for variable environments.** A thorough understanding of the climatic, biophysical and socio-economic conditions that make up farming systems is essential. 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 better enables dialogue between farmers and extension or research workers; consideration of the long-term effects of changes (such as 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 also support sustainability of the natural resources.

## Agribusiness

ACIAR's agribusiness program focuses on researchable issues that can improve the efficiency of value chains and have impacts for smallholders and others involved in agricultural marketing and value addition. Currently, agribusiness work is supported in several ACIAR programs in most of ACIAR's South-East Asian partner countries. ACIAR's agribusiness program is initially focused in Indonesia, and 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 aims to understand 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 the participants in the chain. This includes approaches to better utilise market intelligence to improved performance.
- 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 2007–08

## Crops cluster

- **Crop Improvement and Management (CIM)**. ACIAR is undertaking research in China and India where many of the production constraints are similar to those in Australia; in Cambodia, Laos, East Timor, Iraq and Afghanistan where introduction of improved staple crops can assist food security and technical cooperation is critical to improving local capacity; and through collaboration with several CGIAR centres.
- **Crop Protection (CP)**. ACIAR is undertaking research, particularly in countries neighbouring Australia, such as Papua New Guinea, Pacific Islands (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 (HOR)**. ACIAR is undertaking research in the Philippines and Vietnam (though the ACIAR Crop Protection program) where market access and quality are of high priority, and in the Pacific Island nations, Pakistan and Cambodia where improving productivity and quality management in horticultural and tree crops represent significant opportunities for improving smallholder incomes.

## Livestock and fisheries cluster

- Research on **Livestock Production Systems (LPS)** in Indonesia, Vietnam, Cambodia, Pakistan and the Republic of South Africa and Tibet Autonomous Region (PR China), and **Animal Health (AH)** in Indonesia, Laos and Cambodia, with targeted investments in Papua New Guinea and East Timor.
- The **Fisheries (FIS)** program has a geographical focus on island countries such as Papua New Guinea, the Pacific Islands, Indonesia and the Philippines, as well as selectively complementing other donor programs in Mekong countries (Laos and Vietnam).

## Natural resource management cluster




- Countries in the **Forestry (FST)** program will be emphasised 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 and some Pacific Island countries, Indonesia, Vietnam and Laos.
- The **Land and Water Resources (LWR)** program emphasises agricultural land and water management in China, India and Pakistan and, 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, where soil and fertility issues are likely to be constraints as well as seasonal water scarcity. These include Papua New Guinea, Philippines, Vietnam, Burma and South Africa, and post-tsunami land rehabilitation in Indonesia.

## Economics and policy cluster

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

**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	HOR	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		Special initiatives only	Developing new projects
Indonesia	Developing new projects	Agribusiness program (Indonesia only)			Developing new projects			Special initiatives only	Developing new projects	Developing new projects	Developing new projects	Developing new projects
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			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		Special initiatives only
Myanmar								Special initiatives only		Special initiatives only		
China	Developing new projects			Developing new projects			Developing new projects				Special initiatives only	
DPRK						Special initiatives only	Special initiatives only					
India	Developing new projects			Developing new projects			Developing new projects					
Pakistan			Special initiatives only			Developing new projects	Developing new projects				Special initiatives only	
Bangladesh							Developing new projects					
Other Sth Asia/Iraq				Special initiatives only		Special initiatives only						
Sth Africa											Developing new projects	

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

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

ACIAR projects aim to deliver technical interventions and solutions to the problems that are constraining more productive and sustainable agricultural systems. Over the last couple of years 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 intended beneficiaries or end-users (smallholder farmers, fisher-folk, industry, natural resource managers and policy-makers).

All project proposals should take into account the Project Development Guidelines and relevant Country Priorities outlined in this plan. Early consultation with the relevant ACIAR Research Program Manager is strongly encouraged.

The main initiatives are:

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

This plan outlines indicative priorities by program and country. These priorities are designed 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 socio-economic benchmarking will be conducted, including through the use of scoping studies commissioned by ACIAR as 'Small Research Activities'.

## 2 Consideration of the expected time to impact for new project proposals

ACIAR has defined three 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.* 40 % of ACIAR's new project expenditure is aimed at projects that are designed to achieve significant impacts in the near-term to communities outside those directly involved in the project research and development 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; where there is good local capacity and strong demand-pull for the project outputs from the local end-user groups; and where markets are well defined and accessible. It may also focus on areas where strong linkages with private enterprises,

farmer groups, senior policy-makers or 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 policy-makers 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 are 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 the Project Development Guidelines, Appendix 1 and online at <http://www.aciar.gov.au/web.nsf/doc/COLS-5HXQZQ>.*

## 3 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.

## 4 Capturing data on project impacts more broadly and more regularly

A new impact assessment framework was developed in 2002 (*Measuring the poverty impact of ACIAR projects: a broad framework*, ACIAR Impact Assessment Series Report 19). 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 has adopted a strategy to increase the emphasis on the practical implementation of the results from the research 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. Projects will be divided into three categories (near, medium and long term) based on the expected time to impact (see Appendix 1d).

To help project proponents in defining pathways for the delivery of benefits ACIAR has increased opportunities for development and extension agencies to become involved in new projects. This is especially the case for projects expected to deliver benefits in the near term (0–5 years from project completion) and, to a lesser extent, over the medium term (5–10 years from project completion).

ACIAR seeks to include non-government and community-based organisations (NGOs and CBOs) in better defining the particular development problem from a community perspective and assist in defining research approaches. They also can be involved 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
- utilise a small contract with an NGO/CBO to meet a

specific need for assistance on a particular technology

- involve NGOs/CBOs in communication activities
- involve volunteers in project activities, through appropriate agencies.

NGO and community-based partners should have an ongoing link to target communities, 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.

Further details on engaging with such agencies are available through the ACIAR website, under 'Project Development Guidelines'. This includes broad issues to be addressed in engaging with NGOs and CBOs and information needed to develop project proposals where such agencies are involved.

All project proposals should take into account the project development guidelines and relevant country priorities outlined in this plan. Early consultation with the relevant ACIAR Research Program Manager is strongly encouraged.

# Appendix 2: ACIAR's 2007–08 program and Australia's national research priorities

On 5 December 2002, the Prime Minister announced Australia's first set of National Research Priorities (NRPs) ([www.dest.gov.au/priorities](http://www.dest.gov.au/priorities)). The priorities are:

1. An environmentally sustainable Australia
2. Promoting and maintaining good health
3. Frontier technologies for building and transforming Australian industries
4. Safeguarding Australia.

During 2003, the Government worked with the social science and humanities research communities to enhance and refine the national research priorities framework. In March 2004 the Australian Minister for Science announced that an additional goal would be added under each of the four National Research Priorities:

- Responding to climate change and variability (Environmentally sustainable Australia)
- Strengthening Australia's social and economic fabric (Good health)
- Promoting an innovation culture and economy (Frontier technologies)
- Understanding our region and the world (Safeguarding Australia)

To complement the National Research Priorities, the Australian Government introduced a set of Rural Research and Development Priorities in 1994, which were updated in 2007 ([www.daff.gov.au/agriculture-food/innovation/priorities](http://www.daff.gov.au/agriculture-food/innovation/priorities)). These Rural R&D Priorities aim to guide R&D and foster innovation in the Australian rural sector in the face of continuing economic, environmental and social change and to position rural industries to ensure their long-term competitiveness and sustainability.

The new national research priorities were released in response to several policy reviews, in particular the 2006 Agriculture and Food Policy Reference Group Report. They focus on five major challenges to rural industry;

- Productivity and Adding Value
- Supply Chain and Markets
- Natural Resource Management
- Climate Variability and Climate Change
- Biosecurity

Building innovation skills and advancing technology were also identified as key priorities for meeting these challenges and supporting research.

These priorities sit alongside the National Research Priorities, and as such help to focus rural research organisations like ACIAR in terms of key areas in which the NRP's relate to rural and regional Australia.

**Table 1. Relationship between the National Research Priorities and the Rural Research and Development Priorities**

National Research Priorities	Rural Research and Development Priorities
An environmentally sustainable Australia	Natural Resource Management
	Climate Variability and Climate Change
Promoting and maintaining good health	Productivity and Adding Value
	Supply Chain and Markets
Frontier technologies for building and transforming Australian industries	Innovation skills
	Technology
Safeguarding Australia	Biosecurity

Commonwealth research bodies, including ACIAR, are required to report annually on progress in the implementation of the priorities. This progress is in the context of an Implementation Plan that ACIAR forwarded to the Minister for Science after approval by the Board of Management in May 2004. ACIAR's Plan focused on priority 1: an environmentally sustainable Australia and priority 4: safeguarding Australia.

An annual progress report against the NRP framework was submitted to the NRP Study Committee in October 2006 covering ACIAR's relevant research activities for the period 2005–06.

In 2007–08 additional emphasis will be given by ACIAR to the National Research Priorities within the broader framework of funding priorities related to Australia's overseas aid agenda. This will continue to relate mainly, but not exclusively, to the national priority goals of 'an environmentally sustainable Australia' (theme 1) and 'safeguarding Australia' (theme 4).

In overall terms actual ACIAR expenditure in 2007-08 on theme (1) is expected to increase from \$10.8 m in 2006-07 to \$11.4 m. For theme (4) the increase is expected to be from \$9.6 m to \$11.0 m. Total outlays on NRP relevant projects in 2007-08 are expected to be \$22.5 m, an increase of 10.6% on the previous year.

ACIAR will continue an emphasis on agricultural research to achieve sustainable development and natural resource management in developing countries. This is directly in line with both the NRPs and Australia's international development cooperation policies. Such an approach provides benefits to both the developing partner countries and, in many cases, to Australia. There are a wide range of agricultural project outputs/outcomes. Australian environmental benefits range

from water and soil degradation management to biodiversity and climate change responses.

Under theme (4) the main joint benefits are with projects designed to address invasive diseases and pests which are increasingly both a bilateral and multilateral donor priority in the region. A number of developing countries in the Asia–Pacific region are giving greater recognition to the importance of food safety, animal and crop health and biosecurity measures as a means of realising their agricultural potential in domestic and export markets. These priorities concur with and contribute to Australia’s need to maintain and enhance its agricultural and food health and safety status.

Both in terms of the NRP themes and ACIAR’s overarching objectives of poverty reduction and income growth for the poor, the key benefits of research can be divided into three categories: improved science, improved capacity building, and benefits at the community level. These investments have also enhanced the consistency and quality of food supply within countries that have regular or ongoing shortages of staple foods.

Examples of projects with benefits for Australia and partner countries directly relevant to the NRPs are provided together with summary tables on NRP expenditures and collaborative contributions.

With ACIAR’s increasing emphasis on environmental sustainability in agriculture and the surveillance and control of agricultural pests and diseases in developing countries, there will be an incremental alignment to the NRP agenda. This is also reflected in an increasing level of research competence in Australia in these areas which will, in time, influence future research impacts from NRP-

related investments. Capacity building in these areas in developing countries as part of research projects is also eventually beneficial to Australia and to regional partners. Biosecurity is both a national and an international objective that benefits from effective partnerships. The development of relevant scientific and analytical ability in Australia is an added side benefit of ACIAR’s research agenda which adds to the national comparative advantage across a range of subjects and agricultural disciplines.

ACIAR will also maintain a range of activities which are categorised under the NRP theme 2 – ‘promoting and maintaining good health’, and theme 3 – ‘frontier technologies for building and transforming Australian industries’. Human health is naturally enhanced by improved nutrition and by research on zoonotic disease controls. Both of these themes are directly and indirectly addressed in a range of ACIAR projects. In the case of frontier technologies ACIAR will focus on supporting lower risk, more mature science that is expected to deliver earlier benefits to developing countries including capacity-building impacts. Appropriate and incremental technologies rather than frontier technologies will be emphasised, depending on the community and farmer needs and adoption capacities in individual countries.

A list of selected projects active during 2007–08, which are expected to have Australian benefits directly relevant to priorities 1 and 4, is shown in Table 3 below. Details on individual projects are at [www.aciar.gov.au](http://www.aciar.gov.au). This list is a subset of the investment identified in Table 2 below. This is because the figures in Table 2 include all projects that support Australian research capacity relevant to the National Priorities, irrespective of whether the projects have direct Australian benefits.

**Table 2. ACIAR investment in National Research Priorities (Priorities 1 and 4) 2004–05 to 2007–08 (\$m)**

	2004-05 Actual	2005-06 Actual	2006-07 Actual	*2007-08
1. An environmentally sustainable Australia				
1.1 Water - a critical resource	3,670,006	3,595,824	3,143,657	2,695,567
1.2 Transforming existing industries	976,489	1,605,328	1,937,725	3,099,225
1.3 Overcoming soil loss, salinity and acidity	3,022,547	3,003,456	3,356,603	2,934,800
1.4 Reducing and capturing emissions in transport and energy generation	548,538	567,467	339,275	329,818
1.5 Sustainable use of Australia’s biodiversity	2,298,035	2,146,015	1,630,232	1,702,635
1.7 Responding to climate change and variability	202,522	359,906	348,314	673,655
<b>Total Priority 1</b>	<b>10,718,137</b>	<b>11,277,996</b>	<b>10,755,806</b>	<b>11,435,700</b>
4. Safeguarding Australia				
4.1 Critical infrastructure	16,986	0	521,548	428,424
4.2 Understanding our region and the world	1,710,926	1,501,763	1,228,493	2,852,121
4.3 Protecting Australia from invasive diseases and pests	6,817,957	7,500,696	7,800,509	7,738,734
<b>Total Priority 4</b>	<b>8,545,869</b>	<b>9,002,458</b>	<b>9,550,550</b>	<b>11,019,279</b>
<b>TOTAL PRIORITIES 1 AND 4</b>	<b>19,264,006</b>	<b>20,280,455</b>	<b>20,306,356</b>	<b>22,454,979</b>

\* *Expected investments for 2007–08*

**Table 3: Selected projects in 2007–08 with Australian benefits directly relevant to Australia’s National Research Priorities**

Priority 1: An environmentally sustainable Australia

Priority goals	ACIAR projects	Key Australian project outputs
1.1 Water: a critical resource	CIM/2005/111	More effective water use by rain-fed wheat in China and Australia
	FIS/2002/001	Developing aquaculture in degraded inland areas in India and Australia
	HORT/2003/045	Improvement of vegetable production and postharvest management systems in Cambodia and Australia
	HORT/2005/142	Improving mandarin production in Bhutan and Australia through the implementation of on-farm best management practices
	HORT/2005/160/1	Increasing citrus production in Pakistan and Australia through improved orchard management techniques
	LWR/2000/013	Sustainable agriculture in saline environments through serial biological concentration
	LWR/2004/035	Technology for direct drilling into rice and other heavy stubbles in Pakistan and Australia
	LWR/2005/144	Optimising canal and groundwater management to assist water users’ associations in maximising crop productivity and managing salinisation in Pakistan and Australia
	LWR/2006/076	Rainwater harvesting and soil water conservation to improve water productivity and farmers’ livelihoods in north-west China and south-western Australia
1.2 Transforming existing industries	SMCN/2003/035	Improving the utilisation of water and soil resources for tree crop production in coastal areas of Vietnam and New South Wales
	HORT/2003/045	Improvement of vegetable production and postharvest management systems in Cambodia and Australia
	HORT/2005/142	Improving mandarin production in Bhutan and Australia through the implementation of on-farm best management practices
1.3 Overcoming soil loss, salinity and acidity	HORT/2005/157/1	Optimising mango supply chains for more profitable horticultural agri-enterprises in Pakistan and Australia
	ASEM/2000/109	Farming systems research for crop diversification in Cambodia and Australia
	ASEM/2002/051	Sustaining and growing landcare systems in the Philippines and Australia
	ASEM/2003/011	Herbicide use strategies and weed management options in Filipino and Australian cropping
	FST/2003/002	Development and evaluation of sterile triploids and polyploid breeding methodologies for commercial species of Acacia in Vietnam, South Africa and Australia
	SMCN/2002/085	Utilising basic soil data for the sustainable management of upland soils in Vietnam and Australia
1.4 Reducing and capturing emissions in transport and energy generation	SMCN/2004/069	Minimising agricultural pollution to enhance water quality in Laguna de Bay (Philippines) and Mt Lofty Ranges (Australia)
	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
1.5 Sustainable use of Australia’s biodiversity	LWR/2004/035	Technology for direct drilling into rice and other heavy stubbles in Pakistan and Australia
	FIS/2001/058	Sustainable tropical spiny lobster aquaculture in Vietnam and Australia
	FIS/2002/074	Capacity development to monitor, analyse and report on Indonesian tuna fisheries
1.7 Responding to climate change and variability	FIS/2004/065	Culture of promising indigenous fish species and bioremediation for barramundi aquaculture in northern Australia and PNG
	ASEM/2003/009	Bridging the gap between seasonal climate forecasts and decision-makers in agriculture
	ASEM/2006/129	Early warning for low rainfall periods and preparedness for crop management and storage
	SMCN/2002/033	Seasonal climate forecasting for better irrigation system management in Lombok

#### Priority 4: Safeguarding Australia

Priority goals	ACIAR projects	Key Australian project outputs
4.2 Understanding our region and the world	ASEM/2003/015	Enhancing PNG smallholder cocoa production through greater adoption of disease control practices
	FIS/2004/065	Culture of promising indigenous fish species and bioremediation for barramundi aquaculture in northern Australia and PNG
	FST/2003/025	Community partnerships for plantation forestry: enhancing rural incomes from forestry in eastern Indonesia and Australia
4.3 Protecting Australia from invasive diseases and pests	AH/2004/020	The development of a national surveillance system for classical swine fever, avian influenza, and foot and mouth disease in Indonesia
	AH/2004/040	The epidemiology, pathogenesis and control of highly pathogenic avian influenza (HPAI) in ducks in Indonesia and Vietnam
	AH/2006/156	Risk assessment of livestock movements for disease transmission in Eastern Indonesia and Eastern Australia
	AH/2006/157	Improved biosecurity for animal diseases in Papua New Guinea
	CIM/1999/072	Oilseed Brassica improvement in China, India and Australia
	CP/1998/005	Managing pest fruit flies to increase production of fruit and vegetable crops in Vietnam
	CP/2000/043	Huanglongbing management for Indonesia, Vietnam and Australia
	CP/2003/042	Fruit fly management in Papua New Guinea
	FIS/2002/075	Application of PCR for improved shrimp health management in the Asian region
	FST/2002/112	Domestication of Meliaceae species in South-East Asia and Australia, particularly management of the problem of <i>Hypsipyla robusta</i> attack
	FST/2004/053	Establishing forest pest detection systems in South Pacific countries and Australia
	HORT/2003/046	Integrated control of powdery mildew and other disease, weed and insect problems in squash in Tonga and Australia
	HORT/2003/071	Integrated pest management and supply chain improvement for mangoes in the Philippines and Australia
	HORT/2004/030	Control of Asian honeybees in the Solomon Islands
	HORT/2004/049	Improved farming systems for managing soil-borne pathogens of ginger in Fiji and Australia
	HORT/2005/142	Improving mandarin production in Bhutan and Australia through the implementation of on-farm best management practices
	HORT/2005/153/1	Development of integrated crop management practices to increase sustainable yield and quality of mangoes in Pakistan and Australia
HORT/2005/160/1	Increasing citrus production in Pakistan and Australia through improved orchard management techniques	

## Appendix 3: Benefits to Australia

‘This Government has always held the view that an effective and well targeted aid program, focusing on the alleviation of poverty and the promotion of sustainable development, is clearly in the national interest. This view is even more relevant today as the links between regional development and Australia’s national interest become increasingly intertwined.’ (*The Hon Alexander Downer MP, Minister for Foreign Affairs, at the launch of the Australian Aid White Paper, National Press Club, 26 April 2006*)

‘Delivering Australia’s aid will be based on partnerships. We will use our aid to reach out to the region and mobilise new partnerships that promote closer ties between Australia and our neighbours.’ (*The Hon Alexander Downer MP, Minister for Foreign Affairs, Australian Aid: Promoting Growth and Stability, a White Paper on the Australian Government’s Overseas Aid Program.*)

ACIAR was established to assist Australia’s agricultural scientists to use their skills for the benefit of developing countries as well as Australia. It contributes to Australia’s aid program objectives of advancing Australia’s national interest through poverty reduction and sustainable development. There are benefits for Australia—both indirect (e.g. strengthened international relations and strengthened capacity of Australian agricultural researchers) and direct (improved productivity for Australian farmers and management of biosecurity threats)—from ACIAR’s work. Australia also benefits from the funding that Australian R&D providers receive to support their involvement as partners in ACIAR projects (see map at the end of this appendix).

A recent independent review of all impact assessment studies included in ACIAR’s Impact Assessment Series Nos 1 to 29 (*Review of the returns to ACIAR’s bilateral R&D investments, Impact Assessment Series 35, August 2005*) has provided a summary of the benefits which have been measured. This review has shown that for the 8% of projects formally evaluated, the present value of benefits to all countries has been \$3424 million (2004 dollars) and, of this, \$460 million (14%) were benefits accruing to Australia. This indicates that the Australian benefits alone for this small sub-set of projects funded has covered nearly half of the total cost of ACIAR since it commenced operation in 1982.

A more thorough independent review of the benefits to Australia from ACIAR’s research funding was recently released (*Benefits to Australia from ACIAR-funded research, Impact Assessment Series 39, September 2006*). Below is a description of a wider range of benefits to Australia, some of which are yet to be formally quantified in economic terms.

### Field Crops

The vast majority of crops that comprise Australian production are not native to Australia. Thus breeding programs in Australia must always look overseas for new sources of germplasm. ACIAR has been at the forefront of

advanced Australian institutions catalysing project-based germplasm exchange to minimise agricultural vulnerability and for mutual benefit to Australia and overseas partners.

The sugar industry—where ACIAR-supported intensive scientific collaboration between Chinese and Australian sugar researchers—provides a clear example of the benefits of such projects facilitating germplasm exchange. Specifically, useful genes from wild relatives have been incorporated into domesticated sugar cane varieties using Australian know-how coupled to manpower resources in China. Immediate benefits include enhanced plant stress resistances and improvements in yield and quality, with both countries now enjoying a significantly broader genetic base to underpin a key primary industry.

Similarly, key interchange of genetic stocks of *Brassica* species among China, India and Australia has been funded by ACIAR. The genetic make-up of the plant material from the three countries was quite distinct and all participating countries have now broadened the genetic bases for their *Brassica* industries. In Australia, canola breeders are exploiting the many new traits now available to them as a result of the collaboration. Other Australian crop industries supported in this manner include field peas and faba beans, again through collaborative projects with China.

Much of the research undertaken by ACIAR builds capacity in the management of biotic and abiotic stresses of crops, particularly emerging cropping industries. For example, anthracnose resistance, found in white lupins collected from Ethiopia with ACIAR sponsorship, has been incorporated into Australian cultivars. Anthracnose, with the potential to devastate the lupin industry, was first identified in lupins in Australian conditions in 1997.

As well as supporting bilateral projects, ACIAR, on behalf of the Australian Government, administers Australia’s contribution to the International Agricultural Research Centres. Benefits from their crop improvement work flow to Australia as well as to developing countries. The investment in the International Maize and Wheat Improvement

Centre (CIMMYT) is a prime example. More than 90% of Australian wheat has some CIMMYT ancestry and, in turn, many Australian wheats contributed to CIMMYT's genetic base. The spill-over benefits to the Australian industry were revealed in a 2004 study by NSW Agriculture that showed productivity improvements in Australian wheat, attributable to CIMMYT research, offset falls in world wheat prices. CIMMYT research has improved global wheat supply, lowering prices. For the Australian wheat industry, this loss would have been far greater if not for the advantages from access to CIMMYT germplasm.

Wheat varieties resistant to barley yellow dwarf virus (the worst viral disease of wheat in Australia and China) have been developed, following ACIAR support for pioneering breeding techniques. The first commercially available varieties, developed through this technique, are now available in Australia. Stem, leaf and stripe rust can cause losses in wheat productivity. An ACIAR project identified genes imparting resistance to wheat rust diseases. These traits have been incorporated into improved wheat varieties in Australia, India and Pakistan, contributing to improved wheat rust controls.

ACIAR has supported work by the International Centre for Agricultural Research in the Dry Areas (ICARDA) through collaboration with the Perth-based Centre for Legumes in Mediterranean Agriculture (CLIMA). Scientists have collected germplasm for conservation and use in breeding programs—comprising cereal and pasture, forage and food legume species, their wild relatives and progenitors, along with rangeland species—from the republics of Central Asia and the Caucasus. Almost 1500 accessions with representatives from 140 species and 46 genera were collected. Salt- and drought-tolerant species collected have particular interest for Australia. Australia's expanding lentil and legume crop industries are receiving more than \$13 million of flow-on benefits each year through ACIAR's support for ICARDA research into lentils, faba beans and other crop varieties.

In 2004 a new kabuli chickpea with a 6% yield advantage was released to farmers in Western Australia and Queensland. *Kimberley Large* is the latest of nine varieties, based on ICARDA germplasm, released in Australia over the past two years. It is resistant to *Heliothis* infestations (the main pest of chickpea in Australia) and has demonstrated some resistance to nematode infection.

ACIAR also supports work by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). ICRISAT sorghum lines have led to the introduction of improved midge resistance combined with desirable white grain and tan plant colour, while cold-tolerant chickpea varieties from ICRISAT have been widely grown in Western Australia. An independent study by NSW Agriculture suggested that ICRISAT research has an aggregate benefit to Australia of over \$ 1.5m annually (in 1996 dollars).

## Animal health and biosecurity

Australian livestock industries benefit from the geographic isolation of Australia, particularly in being free of a number of diseases. This disease-free status provides advantages in the export of livestock and livestock products, particularly from the red meat sector. The poultry and pig sector, are mainly domestically focused, and are free from serious disease threats. ACIAR has substantially boosted Australian capacity to understand the disease threats in the Asia-Pacific region and to develop appropriate responses to maintain disease freedom.

A rapid diagnostic test for foot-and-mouth disease developed in collaboration with Thailand enables the confirmation of the disease in a matter of hours, saving vital time in containing outbreaks of the disease. A serological survey for diseases in Lao PDR's village cattle populations enabled scientists to confirm that Australia's disease diagnostic systems can detect the circulating foot-and-mouth wild virus types and identify infected animals in Indochina. A rapid test for Classical Swine fever can be used in Australia for routine surveillance to exclude this disease as a cause of death in pigs. Foot rot control and eradication in sheep and goats has been a long term goal of the Australian sheep industry. Simple approaches to control foot rot (developed in ACIAR projects in Nepal and Bhutan) has been utilised in current approaches in Australia to better manage this debilitating disease.

University of Queensland scientists, aided by observations from project work in Vietnam, were able to diagnose a severe outbreak of Pasteurellosis in pigs in south-east Queensland. An improved vaccine is now developed and marketed as a result of project work. Surra, a blood parasite of cattle and horses is present throughout the region but not in Australia. It causes anaemia, death and reduced productivity. A test has been developed by a team at Murdoch University in association with a project in the Philippines. This test is now used by the Australian Quarantine and Inspection Service for monitoring potential incursions of the disease into northern Australia.

At the Australian Animal Health Laboratory, CSIRO collaborative work with the Newcastle disease heat-adapted vaccine brought knowledge of the disease that has helped enormously in formulating the response to the Newcastle disease outbreaks in NSW in recent years. This has helped in the quick and effective management responses that to date have stopped the spread of the disease. Infectious Bursal disease is one viral infection that limits the ability of poultry to mount an immune response to a range of diseases. The knowledge gained from a Melbourne University–Indonesian collaboration is important to the Australian industry so it can be prepared for the threat of introduction of new strains of this virus potentially through wild birds.

Another aspect of ACIAR-supported research is opening up trade options for the export of animals and animal products. Introduction of appropriate testing and survey methodologies, and training of local researchers to the Philippines, has established the types of tick-borne diseases present, their distribution and prevalence. Testing demonstrated that Australian parasite strains in imported cattle are not a problem, as the diseases they carry are already present in the Philippines. This has greatly improved the trading relationship in cattle between the two countries, as the detection of diseases can be more easily determined and is less likely to result in disputes. The development of a reliable and accurate diagnostic test for bluetongue disease in cattle and sheep facilitated a change in Chinese quarantine policy to allow the importation of Australian live cattle. The project provided the basis for a mutually acceptable quarantine procedure between Australia and China relating to the export of live cattle. The outcomes of economic studies of the Chinese wool industry, with a focus on the production and marketing of Chinese raw wool, have indicated that Chinese and Australian wool were not directly competitive, leading to the lowering of Chinese tariffs on Australian wool and consequent benefits to both countries.

A range of new projects will assist in the control of some of the serious viral disease threats in our near neighbours such as Highly Pathogenic Avian Influenza and Classical Swine Fever. The experience gained in such research provides a team of highly skilled scientists that are able to respond effectively to disease incursions should they occur.

### **Animal production**

Genetic manipulation of animals to improve productivity has been a key tool in developed livestock economies. The identification of superior genotypes has traditionally been slow but now can be accelerated by the use of 'gene markers' for the desired traits. There have been few successful examples of this approach in livestock. However, one has proven very reliable in Indian sheep, the *Fec B* gene, to improve lambing percentages. An ACIAR project at the University of New England has discovered and shown that such an approach is successful in India and why its application in Australian Merino was not successful in the first instance. Recent discoveries have renewed the optimism that improved lambing rates can be achieved—one of the key economic drivers for sheep farmers.

The involvement of the CRC for Beef Genetic Technologies in South Africa has been beneficial in both South Africa and Australia. The incidence of gene markers for beef quality traits has been determined in several African breeds, and is being exploited in South Africa and Australia through the importation of semen. In Australia, the CRC has addressed the issue of how to change the carcass and meat quality attributes of tropical breeds without compromising key reproductive performance and adaptation to harsh environmental conditions. Heritability estimates are

now available for traits such as female reproduction, feed conversion efficiency and meat quality traits that can and are being used by beef producers in northern Australia to improve their Brahman and Tropical Composite herds.

Lucerne is one of the most important forage crops in Australia and China—where it has been grown for over 3000 years. Common problems are shared between countries, particularly increasing soil salinity and acidity, both of which have negative effects on lucerne production. The South Australian Research and Development Institute, which is the major lucerne breeding agency in Australia, and the University of Tasmania, have developed a unique and highly efficient and effective laboratory technique to screen breeding lines for tolerance to salt and aluminium/acidity. This work has improved the scientific understanding of stress tolerance in lucerne and has fundamentally changed the approach to breeding for salt and aluminium/acid tolerance in lucerne and other similar plants.

International investment in tropical forage research was high for over 30 years from the 1960s, with Australia leading the way, but much of that work remained inaccessible in grey literature and reports. With ACIAR support, CSIRO and many Australian, European, South American and developing country partners have consolidated that information into a software package entitled 'Tropical Forages: an interactive selection tool'. In Australia the demand for information on forage options has changed from broad-scale applications, such as with the use of stylosanthes species and buffel grass species, to niche applications, particularly for the production of high quality forages. Much of the hands-on experience is no longer available, but it has been captured in this software tool which is now being used by producers and extension staff in the tropics and subtropics to explore options in these new situations, and it is being used as a teaching aid in tertiary institutions.

### **Horticulture industries**

Access to germplasm varieties for citrus could substantially enhance some horticulture industries. Through an ACIAR-supported project, East Asian citrus germplasm has been conserved and is now being exchanged. Much of this germplasm shows high tolerance to environmental stresses—sought-after characteristics for national improvement programs. The range of unique germplasm brought into Australia, which would have been impossible without the project, should bring many long-term benefits to the industry.

Improved lower cost technology for treating mangoes for fruit fly, the major pest of horticulture throughout much of the world, is now being used commercially in the Northern Territory. This Australian-designed forced air treatment system, first developed under funding from Horticulture Australia and trialled through an ACIAR project, has lifted throughput capability for the Australian mango industry in supplying export markets.

An ACIAR project involving the Queensland Fruit and Vegetable Growers is helping horticultural industry groups in south-east Queensland to better analyse the environmental issues affecting their industry. Participating groups have become more involved in the self-development of activities and initiatives to improve member awareness and facilitate member progress on issues related to overall farm sustainability. Environmentally focused field days; farm walks and discussion groups; partnerships with natural resource management groups; and initiatives at the government, community, education and industry levels are under way. Interest in market-focused auditing systems such as Environmental Management Systems and the increasing involvement of farmers in on-farm environmental monitoring systems such as Waterwatch have also resulted from the project.

ACIAR has funded a number of projects on improved production methods and better pest and disease management as well as heat disinfestation of tropical fruits which have particularly benefited the Australian mango industry. Benefits include improved orchard management, quality and shelf-life of Australian fruit; improved contribution to the development and maintenance of local markets with strict fruit fly management systems (such as South Australia); and development of export markets, such as the Japanese market.

### Forestry management

Australia now boasts a plantation eucalypt estate of over 700,000 hectares, mostly established over the last two decades. Although the eucalypts are essentially an Australian group, the domestication of these as plantation species has occurred largely offshore. ACIAR has made a significant contribution to this, in particular through two long-running projects – ‘Seeds of Australian Trees’ and ‘Domestication of Australian Trees’. Together with some earlier projects, these built on the foundation laid by the work of others and have provided the data on the adaptation of a range of Australian species, in particular eucalypts, to a variety of site types and climatic zones. They are providing a valuable guide to the silvicultural requirements of species with the potential for various purposes and adapted to various site types in the emerging Australian hardwood plantation industry.

A range of ACIAR pest and disease projects in Asia and the Pacific have significantly improved regional capacity for forest health surveillance. A regional approach to this issue is essential, and threats to Australian forests are significantly reduced through over-the-horizon surveillance. An excellent example is the work conducted on guava rust, *Puccinia psidii*, which is not yet in Australia but is potentially a devastating pathogen of Australia’s eucalypt forests. The pioneering work supported by ACIAR is now underpinning the Australian Government strategy to manage this threat, now considered as serious since the arrival of the pathogen in Hawaii.

### Helping the emerging aquaculture industry

Over-fishing of trochus shellfish populations, resulting in declining populations in north-western Australia and throughout the Indo-Pacific, is being reversed through successful research efforts to culture and release juvenile trochus. The spiral conical trochus shells are valued for use in jewellery and fashion garments. The opening of the first commercial trochus hatchery, by the Kimberley Aquaculture Aboriginal Corporation at Broome, followed an ACIAR project examining the re-establishment of trochus fisheries through reef reseeded. The success of trials investigating the broodstock collection for spawning, release of juvenile trochus and reseeded experiments helped prove the viability of a commercial hatchery.

The development of effective small-scale hatchery production and pond grow-out technologies for mudcrabs (*Scylla* spp.) has created the basis for large-scale production trials in collaboration with industry partners in Australia and the Philippines. Several private companies are testing the technologies and there is the opportunity for rapid take-up of the research outcomes, promising a lift in crab production that will ease the pressure on heavily exploited wild stocks.

Culture of mudcrabs has involved studies of Northern Territory wild stock. This complements a \$2.4 million hatchery project funded by the Fisheries Research and Development Corporation (involving the Northern Territory Department of Industry and Fisheries and the Queensland Department of Primary Industries and Fisheries). The hatchery project is a direct follow-on from the ACIAR project and targets an economical scale-up of the hatchery technology. In north Queensland, farm trials at Seafarm have produced the first commercial harvest of cultured market-sized crabs.

Development of fishmeal substitutes for feeding farmed fish has provided the basis for diets for silver perch (*Bidyanus bidyanus*), a species new to aquaculture. Major nutritional requirements for silver perch are now known and the potential for a wide range of available ingredients thoroughly evaluated. Commercial feed manufacturers now have the information to formulate low-cost, effective diets using Australian agricultural ingredients, with no fishmeal.

Remediation technologies for fish ponds affected by acid sulfate soils are being trialled in Australia (already in the Northern Territory, Queensland and New South Wales) and Indonesia. The scientists have developed effective, affordable procedures including flushing with seawater, laying down a capping material on pond bottoms, treating acidity with lime and leaching the soils. User-friendly manuals on pond management are being produced to aid Australian aquaculture to meet strict environmental guidelines, benefiting the coastal environment in shrimp-farming areas.

## Biosecurity benefits

Many of the agricultural pests and diseases that are a threat to Australia are also issues in South-East Asia and the Pacific. ACIAR-supported research aimed at these issues is contributing to an effective offshore-buffer zone for Australia and is helping Australian scientists gain expertise that will enable them to spring into action should any incursion take place.

ACIAR and Griffith University project work has yielded information on the presence of pest fruit fly species and habitats in countries adjacent to Australia, particularly in relation to the risks of fruit flies entering Australia. Research on fruit flies in the region has contributed towards development of regional quarantine strategies to manage fruit fly problems within neighbouring countries. Research has been invaluable in helping Australian quarantine authorities establish the identity of flies and work out the host fruit range of Asian fruit flies recently discovered in the Torres Strait islands.

A joint ACIAR and CSIRO Entomology project identified a biological control for the banana skipper butterfly, which devastated banana trees in Papua New Guinea. Introduction of the control has also removed a major threat to the Australian banana industry, with benefits to Australia calculated around \$170 million.

In Australia, research from ACIAR projects has underpinned the methodologies now being applied for active animal health surveillance in the extensive beef industry sector of Queensland. For example, the Australian Quarantine and Inspection Service have adopted methodologies developed for the identification and diagnosis of *Trypanosoma evansi*, a protozoan that can infect a wide range of animals. The information generated is being shared in the ongoing tripartite agreement for the Northern Australia Quarantine Service involving Papua New Guinea, Indonesia and Australia.

New insights have been obtained into the complex relationships between honeybees and the parasitic mites they carry, which is timely in view of the recent incursion of the Asian bee into northern Australia and the discovery of the varroa mite in New Zealand. Findings about bee mites in West Papua and Papua New Guinea are relevant to assessments of risk to the bee industries there and in Australia. Diagnostic tools, based on the international work, have been developed by CSIRO for AQIS to evaluate the significance of incursions of bees at Australian ports. These tools are used to determine the species of both the bees and the mites they carry, and so inform the appropriate response. As well, understanding the relationship between honey and forest seed production has led to increases in supplemental feeding of bees and the placement of hives in eucalypt orchards to promote seed production.

## Farming systems: management of salinity

Salinity is a major short- and long-term threat to farming lands in many countries, with areas in Australia and Pakistan badly affected. ACIAR-supported research into rehabilitating saline land has delivered benefits to Western Australia. The basis of this research is the profitable and integrated use of suitable plant species, combined with improved farming practices, to better utilise saline land in a sustainable manner. ACIAR has funded projects identifying salt-tolerant plant and tree species, extending the results of previous research, including by the Western Australian Department of Agriculture over the past 30 years, into species useful for rehabilitating salt-affected land. This includes selections of forage shrubs that are palatable and productive in saline/alkaline and seasonally waterlogged soils.

Waterlogging of poorly drained soils in cropping areas alters soil characteristics, cutting wheat productivity by up to 150 kg per hectare in severely affected areas. This is exacerbated further in saline soils under waterlogged conditions. An ACIAR-funded project examined the damage caused by waterlogging in Australia and India, gaining greater understanding of the physiology of waterlogging tolerance that leads to identification of traits for use in breeding. Environmental factors, particularly soil sodicity and alkalinity, are being characterised in key regions. Through the use of permanent raised-bed technology to improve yields and prevent waterlogging of fragile soils in Western Australia and Pakistan, scientists are assessing the potential for rehabilitating waterlogged, salt-affected land.

## Benefits to Australia through increased water productivity

Agriculture, in particular irrigated agriculture, is the major user of freshwater resources in most developing countries and in Australia. Growing populations and associated urbanisation are also accelerating water consumption. ACIAR projects have employed two broad strategies to generate improved water productivity. The first set of strategies is implemented at the irrigation scheme or catchment level, where efficiencies can be achieved through optimised allocation of water and reducing system leakages. For example, ACIAR has funded a project to both assess use of land and water resources (and develop a management framework) for river catchments across NSW. This framework has been used to assess the sustainability of 27 coastal lakes in Australia.

The second set of strategies focuses on things that farmers can do to optimise water efficiency through improved on-farm practices, including the use of water efficient crop varieties. Through the use of Australian and Indian germplasm, the Queensland Department of Primary Industries is anticipating that new drought-tolerant cultivars will be released in Australia and India for use in drought-prone areas in the next few years. In collaboration

with rice irrigators in south-west NSW, a joint ACIAR-RIRDC-GRDC-funded project demonstrated the value of adopting permanent raised beds in rice-based cropping systems. Incorporating lateral raised beds can improve the returns per megalitre of water used from \$96 to as much as \$136 per ML. Permanent raised beds mean less cultivation, better soil structure, more efficient flood irrigation, and increased flexibility of cropping operations.

Finally, irrigation scheduling to more accurately meet the water requirements of a crop is an important way to reduce water wastage and increase efficiency of water use by plants. ACIAR projects have had a significant impact on the management of irrigation schemes in Victorian citrus orchards by using refined scheduling techniques.

ACIAR projects have also delivered substantial water savings for the Australian community. Potential water savings in Australia arising from four ACIAR projects studied in detail conservatively total 3.1 million megalitres, with actual adopted savings of over a million megalitres—the equivalent of more than one million Olympic swimming pools. These projects include work on growing more rice with less water (in the Murrumbidgee and Coleambally Irrigation Areas), work on water saving (in the Ord River Irrigation Area), Serial Biological Concentration (in the Murray Darling Basin) and Controlled Traffic Farming (in Darling Downs and Northern NSW).

### **Managing shared fisheries resources**

Little is known about the populations of sharks and rays in the shared waters between Australia and Indonesia. A project involving Murdoch University assessed the extent to which fishers from Indonesia depend on these species, and their importance as another source of fishing income. The project team examined strategies to improve stock evaluation and management, including determining population status and identifying the species shared between the two countries.

Assessments of shared Indonesia–Australia fish resources, aimed at improving the sustainability and productivity of red- and gold-band snappers, have facilitated bilateral negotiations to develop complementary management strategies by Australia and Indonesia. The project has also identified Indonesian and Australian nursery areas for red snapper and other important habitats, and established sustainable catch levels.

### **International linkages—scientific networks**

Building scientific networks is important in all ACIAR projects, both for Australian and developing country scientists. Often the expansion of these networks provides an excellent means of disseminating scientific findings and project outputs.

The Asia–Pacific Grouper Network, which was established under an ACIAR project, has been expanded to encompass

all marine finfish culture and is now called the Asia–Pacific Marine Finfish Aquaculture Network. The network includes other species such as sea bass, snapper and cobia. Many of the issues relating to aquaculture development of these species, particularly seed supply and feed development, are similar to those with groupers. The Network of Aquaculture Centres in the Asia–Pacific (NACA) has now included facilitation of the network in its work program. The network is being used as the basis for establishing other networks (for example, grouper health, reef fisheries and environment).

### **New modelling and assessment tools**

The Agricultural Production Systems Research Unit (APSRU) is a consortium of researchers from CSIRO and the Queensland Departments of Primary Industries and Fisheries, and Natural Resources. As Australia's main research unit concerned with the application of computer simulation models to predict crop yields and improve the management of complex dryland cropping systems, its work has led to better farming practices, regional land and water management, and policy formulation. Its software APSIM (Agricultural Production Systems Simulator), partly developed and enhanced through ACIAR funding, is internationally recognised. For instance, the international agricultural research centres ICRISAT and CIMMYT have applied it to improve farming systems in India and southern Africa.

An ACIAR-funded Indonesia–Australia collaboration has also developed an 'Integrated Assessment Tool' that brings together crop and livestock modelling modules with economic and resource information. The tool has been further developed by CSIRO Sustainable Ecosystems and applied in Australia in the 'grain-and-graze' initiatives supported by the Grains R&D Corporation, particularly in southern Queensland where there is significant integration of crop and cattle production.

### **Benefits from policy and economics research**

While agricultural productivity is clearly influenced by technical and scientific knowledge, there is considerable evidence to suggest that adoption of research is influenced by institutional and policy settings. Policy research is an increasingly important component of ACIAR's program. The benefits to Australia from the policy research portfolio cannot be separated from the returns to the Centre's scientific and technical project returns given the close interaction of policy and institutional outcomes to the adoption and implementation of productivity-improving systems for agriculture, fisheries and forestry.

Improved policy acceptance in individual ACIAR partner countries can also contribute direct benefits to Australia through:

- increased trade and market access
- direct and indirect protection from pest and disease

incursion

- improved researcher capacity and understanding our regional partners
- enhanced policy linkages across the region
- commercial opportunities through agricultural and general economic development in the region, adding to consumer demand levels.

Recent examples of such research projects designed to achieve mutual benefits for Australia and our partners include an economic analysis of technical barriers limiting agricultural trade with China. This study is being undertaken in conjunction with the International Food Policy Research Institute in USA to help identify the magnitude of technical barriers limiting agricultural trade with China. The capacity-building aspects of the project will involve increased ability to engage in constructive dialogue (within the WTO and in other forums) on technical barriers in order to underpin exports and imports.

A second example is a project to assess the need for agricultural trade liberalisation and domestic market reforms in Indian agriculture. By developing a set of policy

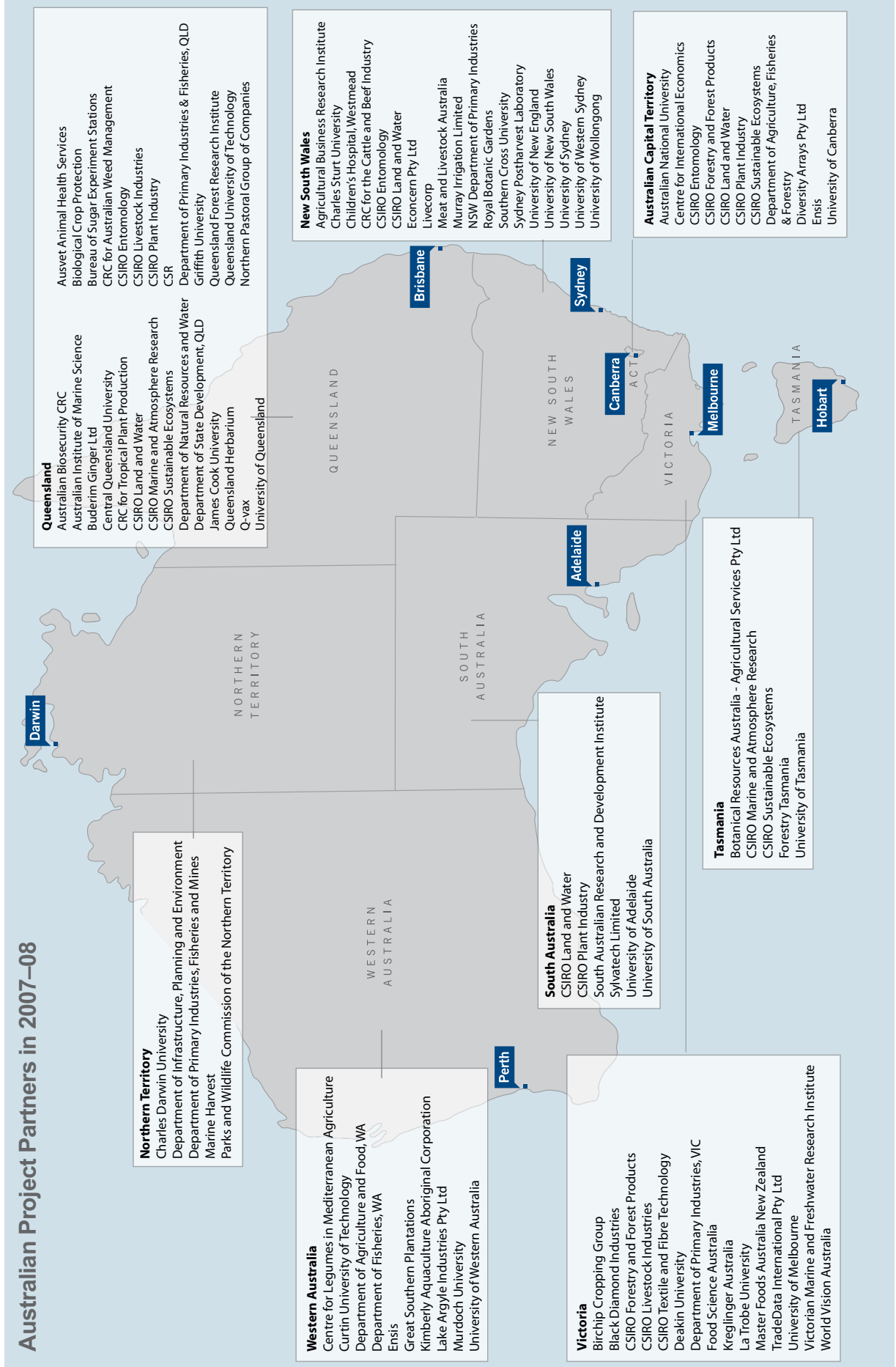
recommendations consistent with India's international agreements, farmers and consumers will be able to gain from the integration of domestic and international markets, facilitating economic growth in the rural areas, employment generation and poverty alleviation. This, in turn, will encourage the adoption of more open international agricultural trade policies, cooperation between India and Australia in trade forums and mutually beneficial bilateral trade and investment flows.

Exploring 'alternative futures' for agricultural knowledge, science and technology is an international partnership to improve the understanding and delivery of new knowledge to farmers which is essential to the development of agricultural industries across a number of developing countries. Alternative scenarios for science and technology policy and their respective outcomes for food supply and demand, together with food security and natural resource use at country and regional levels, will be assessed. These assessments can be utilised by policy-makers to develop their own country-specific long term policies, including in Australia.



*Breeding new plant varieties for disease resistance, higher yield and better grain quality*

# Australian Project Partners in 2007-08



## Appendix 4: Selected world development indicators

	Adult illiteracy % of aged over 15 <sup>1</sup>	Agriculture value added as % of GDP	GDP constant 2000 USD million	GDP growth annual %	GDP per capita constant 2000 USD	Human development index <sup>1</sup> ranking out of 177 countries	Human poverty index <sup>1</sup> ranking out of 103 countries	Internet users 1000s <sup>1</sup>	Agricultural land as % of land area	Life expectancy at birth years <sup>1</sup>	ODA current USD million	Population in millions <sup>1</sup>	Population (rural) as a % of total <sup>1</sup>	Population density <sup>1</sup> people per square km <sup>1</sup>	Public spending on education as a % of GDP <sup>1</sup>	Public spending on health as a % of GDP <sup>1</sup>	Telephone mainlines per 1000 people <sup>1</sup>	Water (access to) % of population <sup>1</sup>
<b>PNG &amp; S Pacific</b>																		
PNG	57.3	25.5	4,731.3	3.0	815.7	139	75	29.5	2.3	56.0	266	5.8	86.7	12.5	..	3.0	12	39
Pacific																		
Fiji	..	15.4	2,810.3	1.7	3,345.6	90	45	72.6	25.2	68.2	64	0.84	49.7	46.0	6.4	2.3	59	47
Solomon Is.	..	..	285.7	4.4	607.9	128	..	6.4	4.2	62.7	122	0.47	83.3	16.3	3.8	4.5	15	70
Vanuatu	74.0	15.0	340.5	6.8	1,591.1	119	49	36.2	12.1	69.2	38	0.214	76.9	17.6	9.6	2.9	33	60
Samoa	..	..	399.3	5.5	2,230.7	75	..	32.7	46.3	70.3	31	0.179	77.7	63.0	4.3	4.3	25	88
Tonga	98.9	28.9	244.4	2.4	2,419.8	55	..	29.4	41.7	72.5	19	0.101	76.2	134.7	4.8	5.5	46	100
Kiribati	..	8.9	76.4	0.3	764.0	..	..	20.5	50.7	62.8	17	0.1	..	137.0	..	..	..	..
<b>Southeast Asia</b>																		
Indonesia	90.4	14.0	287,217.0	5.6	1,302.0	108	41	66.7	25.2	67.4	84	220.6	53.0	115.8	0.9	1.1	46	77
Vietnam	90.3	21.8	52,408.3	8.4	632.2	109	33	71.4	29.6	70.3	1,830	83.1	74.0	249.9	1.8	1.5	70	85
Philippines	92.6	14.4	98,305.9	5.1	1,183.7	84	31	53.9	40.9	70.8	463	81.6	38.1	276.8	3.2	1.4	42	85
Cambodia	73.6	32.9	5,391.3	7.0	383.2	129	73	3.0	30.1	56.6	478	13.8	80.9	77.7	2.0	2.1	..	41
Lao PDR	68.7	46.0	2,855.0	7.0	483.9	133	63	3.6	8.3	55.3	270	5.8	79.7	24.9	2.3	1.2	13	51
East Timor	..	..	..	..	..	142	..	..	22.9	..	..	0.9	73.9	60.4	..	7.3	..	58
Thailand	92.7	9.6	176,602.0	4.5	2,759.4	74	19	109.5	36.2	70.5	2	63.7	68.0	124.7	4.2	2.0	107	99
Burma	..	..	..	5.0	..	130	47	1.3	17.2	60.8	121	50.5	69.9	74.6	..	0.5	8	78
<b>South Asia &amp; Middle East</b>																		
India	61.0	18.6	785,468.0	8.5	717.7	126	55	32.4	60.8	63.5	691	1087.1	71.5	333.0	3.3	1.2	41	86
Pakistan	49.9	21.6	110,732.0	7.8	710.7	134	65	13.2	32.6	64.9	1,421	154.8	65.5	195.7	2.0	0.7	30	91
Bangladesh	41.1	20.5	59,957.0	5.4	422.8	137	85	2.2	69.3	63.5	1,404	139.2	75.3	984.7	2.2	1.1	6	74
Nepal	48.6	40.2	7,346.0	2.3	271.1	138	68	6.6	29.6	62.2	427	26.6	84.7	184.1	3.4	1.5	15	90
Sri Lanka	90.7	16.8	23,478.9	5.3	1,197.9	93	38	14.4	36.5	74.4	519	20.6	84.8	298.7	3.2	1.6	51	79
Bhutan	..	25.8	840.5	5.9	933.9	135	71	22.3	11.6	63.5	78	2.1	89.2	19.1	..	2.6	33	62
Afghanistan	28.1	..	7,168.0	13.8	..	..	..	0.9	58.4	..	2,190	28.6	..	..	..	..	..	39
Iraq	74.1	8.6	12,602.5	46.5	..	..	..	1.3	22.9	63.1	4,658	28.1	..	..	..	..	..	..
<b>North Asia</b>																		
China	90.9	13.1	2,228,860.0	9.9	1,708.6	81	26	72.5	59.5	71.4	1,661	1308	60.5	135.9	2.2	2.0	241	77
<b>Southern Africa</b>																		
South Africa	82.4	3.1	240,152.0	4.9	5,828.9	121	53	78.4	82.0	44.6	617	47.2	41.2	33.8	5.4	3.2	94	88

Source: The World Bank Group, World Development Indicators Online, <http://devdata.worldbank.org/data-query/>, selected years: 2002-2005, data chosen from most recent year available.

1 Source: United Nations Development Program, Human Development Report 2006 Online, <http://hdr.undp.org/hdr2006/statistics/>

## Selected world development indicators: definitions\*

\* Source: United Nations Development Program, Human Development Report 2006 Online, <http://hdr.undp.org/hdr2006/statistics/>

### Adult illiteracy

Adult illiteracy is the proportion of adults aged 15 and above who cannot, with understanding, read and write a short, simple statement on their everyday life. Percentage of adult illiteracy is calculated as 100% minus the adult literacy rate.

### Agriculture value added

Value added in agriculture corresponds to the International Standard Industrial Classification (ISIC) divisions 1–5 and includes forestry, hunting and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the ISIC, revision 3.

### Gross domestic product (GDP)

Gross domestic product is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.

### GDP per capita

This is calculated by dividing GDP by midyear population. See GDP.

### Human development index (HDI)

The HDI is a summary measure of human development. It measures the average achievements in a country in three basic dimensions of human development:

- a long and healthy life, as measured by life expectancy at birth
- knowledge, as measured by the adult literacy rate (with two-thirds weight) and the combined primary, secondary and tertiary gross enrolment ratio (with one-third weight)
- a decent standard of living, as measured by GDP per capita (US\$).

### Human poverty index (HPI)

While the HDI measures average achievement, the HPI measures deprivations in the three basic dimensions of human development captured in the HDI:

- a long and healthy life—vulnerability to death at a relatively early age, as measured by the probability at birth of not surviving to age 40
- knowledge—knowledge-exclusion from the world of reading and communications, as measured by the adult illiteracy rate
- a decent standard of living—lack of access to overall economic provisioning, as measured by the unweighted average of two indicators: the percentage of the population without sustainable access to an improved water source and the percentage of children under weight for age.

### Internet users

People with access to the worldwide network.

### Agricultural Land

Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting

cultivation is excluded. Land under permanent crops is land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber. This category includes land under flowering shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber. Permanent pasture is land used for five or more years for forage, including natural and cultivated crops.

### Life expectancy at birth

Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.

### ODA

Official development assistance (ODA) represents 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), by multilateral institutions and by non-DAC countries to promote economic development and welfare in countries and territories in part 1 of the DAC list of aid recipients. It includes loans with a grant element of at least 25% (calculated at a rate of discount of 10%).

### Population

Refers to the de facto population, which includes all people actually present in a given area at a given time.

### Population (rural)

Rural population is the midyear population of areas defined as rural in each country as reported to the United Nations. It is measured here as the percentage of the total population.

### Population density

Population density is midyear population divided by land area in square kilometres.

### Public spending on education

Public expenditure on education includes expenditures on public education plus subsidies to private education at the primary, secondary, and tertiary levels.

### Public spending on health

Public expenditure on health consists of recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and non-governmental organisations), and social (or compulsory) health insurance funds.

### Telephone mainlines

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

### Water (access to)

Access to an improved water source is the share of the population with reasonable access to an adequate amount of safe water (including treated surface water and untreated but uncontaminated water, such as from springs, sanitary wells, and protected boreholes). In urban areas the source may be a public fountain or standpipe located not more than 200 metres away. In rural areas the definition implies that members of the household do not have to spend a disproportionate part of the day fetching water. An adequate amount of water is that needed to satisfy metabolic, hygienic, and domestic requirements, usually about 20 litres of safe water per person per day.

# Appendix 5: Major crop, livestock and fisheries\* production indicators by partner country

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

## 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 nes	10
Sweet potatoes	520,000	Cattle meat	3,498	Demersal marine fish	2
Sugar cane	450,000			Crustaceans	2

### FIJI

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Sugar cane	2,980,000	Cow milk	57,000	Marine Fish nes	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 nes	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 nes	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 nes	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		

## 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 nes	1
Cassava	9,000	Chicken meat	297		
Sweet potatoes	6,000				
Vegetables, fresh	5,500				

## KIRIBATI

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Coconuts	103,000	Pig meat	876		
Roots and tubers	7,800	Chicken meat	458		
Vegetables, fresh	5,900	Hen eggs	240		
Bananas	5,000				
Taro (coco yam)	2,000				

## 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
Sugar cane	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 nes	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
Sugar cane	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

### PHILIPPINES

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Sugar cane	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 nes	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)	Fisheries	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)
Sugar cane	49,572,000	Cattle meat	3,300	Marine fish nes	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 (MYANMAR)

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Rice, paddy	24,500,000	Cow milk	543,000	Marine fish nes	1,092
Sugar cane	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)
Sugar cane	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 nes	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)
Sugar cane	47,244,100	Buffalo milk	19,700,000	Freshwater and diadromous fish	184
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 nes	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
Sugar cane	6,500,000	Cow milk	800,000	Marine fish nes	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		

## NEPAL

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Rice, paddy	4,100,000	Buffalo milk	894,591	Freshwater and diadromous fish	40
Sugar cane	2,376,103	Cow milk	379,637		
Vegetables, fresh	1,850,000	Buffalo meat	138,969		
Potatoes	1,738,840	Cattle meat	48,783		
Maize	1,716,042	Goat meat	39,186		

## SRI LANKA

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Rice, paddy	3,126,000	Cow milk	142,000	Pelagic marine fish	182
Coconuts	1,950,000	Chicken meat	98,838	Demersal marine fish	37
Sugar cane	1,015,000	Hen eggs	52,000	Freshwater and diadromous fish	31
Plantains	600,000	Cattle meat	29,001	Crustaceans	18
Tea	308,090	Buffalo milk	27,000	Marine fish nes	17

## BHUTAN

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	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 farine fish	4,079

## SOUTHERN AFRICA

### SOUTH AFRICA, REPUBLIC OF

Crops	Total production (Mt)	Livestock	Total production (Mt)	Fisheries	Total production (Mt)
Sugar cane	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 nes	11
Potatoes	1,909,060	Hen eggs	340,000	Cephalopods	11
Grapes	1,700,000	Pig meat	140,040	Crustaceans	4

## Appendix 6: Major forestry indicators for partner countries

Region/country	Total forest area in 2005 (1000 ha)	Percentage of land area in 2005 (%)	Forest plantations in 2005 (1000 ha)	Annual rate of change 2000–2005 (%)
<b>Papua New Guinea and the South Pacific</b>				
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
<b>South-East Asia</b>				
Indonesia	104,986	58	3,399	-2.0
Vietnam	12,931	39.7	2,695	2.0
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
<b>South Asia</b>				
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
<b>North Asia</b>				
China	197,290	21.2	31,369	2.2
<b>Southern Africa</b>				
South 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 7: Acronyms and abbreviations

ACIAR	Australian Centre for International Agricultural Research
ADP	Agricultural Development Policy
AGB	Agribusiness
AH	Animal Health
APAARI	Asia–Pacific Association of Agricultural Research Institutes
APAFRI	Asia–Pacific Association of Forestry Research Institutes
APSIM	Agricultural Production Systems sIMulation (model)
ASEM	Agricultural Systems Economics and Management
ATSE	Academy of Technological Sciences and Engineering (Australia)
AusAID	Australian Agency for International Development
AVRDC	Asian Vegetable Research and Development Institute (Taiwan)
AYAD	Australian Youth Ambassadors for Development
CABI	Centre for Agriculture and Biosciences International (UK)
CARD	Capacity building for Agriculture and Rural Development (Vietnam)
CBO	Community-based organisation
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture (Colombia)
CIFOR	Centre for International Forestry Research (Indonesia)
CIM	Crop Improvement and Management
CIMMYT	International Maize and Wheat Improvement Centre (Mexico)
CIP	International Potato Centre (Peru)
CP	Crop Protection
CSF	Classical Swine Fever
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DPRK	Democratic People’s Republic of Korea
FAO	Food and Agriculture Organisation
FIS	Fisheries
FMD	foot-and-mouth disease
FST	Forestry
FTE	Full-time equivalent (staff)
GNI	Gross National Income
HORT	Horticulture
IARCS	International Agricultural Research Centres
ICARDA	International Centre for Agricultural Research in the Dry Areas (Syria)
ICRAF	World Agroforestry Centre (Kenya)
ICRISAT	International Crops Research Institute for the Semi-arid Tropics (India)
IDM	Integrated Disease Management
IFPRI	International Food Policy Research Institute (USA)
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute (Kenya)
IPGRI	International Plant Genetic Resources Institute (Italy)
IPM	Integrated Pest Management
IRRI	International Rice Research Institute (Philippines)
IWMI	International Water Management Institute (Sri Lanka)
LPS	Livestock Production Systems
LWR	Land and Water Resources
NGO	Non-government organisation
ODA	Official Development Assistance
PIC	Pacific Island countries
PLIA	Policy Linkages and Impact Assessment
PNG	Papua New Guinea
R&D	Research and Development
RPM	Research Program Manager
RSA	Republic of South Africa
SMCN	Soil Management and Crop Nutrition
SPC	Secretariat of the Pacific Community
VCP	Virtual Colombo Plan
WTO	World Trade Organisation