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Appendix 1a: ACIAR's sectoral strategies for 2009–10

While the strategies are presented sector-by-sector, many of the projects funded by the Australian Centre for International Agricultural Research (ACIAR) are multi-disciplinary in nature, reflecting the importance of collaborative research that brings together researchers from relevant disciplines and research units to solve specific agricultural constraints or stimulate new opportunities on cross-cutting research issues.

Field crops

ACIAR targets the major field (broadacre) crops where productivity can be increased through genetic and agronomic research. Crops for which Australia has strong expertise (e.g. wheat, sorghum, canola), other crops that are critical for global food security (including rice and maize), and newer crops for which Australia can share benefits by exchange of germplasm with partner countries (e.g. faba and other beans, chickpea, lentils) are emphasised. ACIAR crop projects often complement or directly support the efforts of CGIAR centres. In addition, broader system questions such as water and fertility management, tillage and crop rotations, and genetic limits to yield potential are addressed.

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

In **biotechnology** ACIAR will focus on applications for 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, as well as tools for managing and using associated information. Potential plant genetic engineering projects will target areas where improvement is difficult to achieve through conventional breeding, and where there are regulatory systems in place that support the use of engineered crops. We usually build upon existing capacity in biotechnology rather than establish the skills and facilities from the beginning. Linkage of biotechnology research groups to

crop improvement breeding programs in partner countries and the integration of information from biotechnology with conventionally generated breeding and pedigree data, is critical.

Cropping systems research encompasses a broader range of applications of proven technology, focusing on improved management and profitability of soil fertility, conservation tillage, equipment and system interactions, as well as effective participatory linkages between researchers, service providers and farmers of both genders. Therefore, this research is often associated with livestock, aquaculture and tree crop research, as well as climate change and policy research, in order to devise systems that are biologically efficient and have high productivity to improve food security and household incomes.

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

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

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

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

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

Horticulture

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

ACIAR will continue to support research on management of pests and diseases and postharvest handling of major fruit crops, particularly tropical and subtropical fruits, as well as support work that integrates technology for fruit production systems. There will be less emphasis on fruit germplasm selection and breeding because of long lead times to impact. ACIAR will significantly **increase its investment in vegetables** for developing countries. These provide opportunities for increasing cash incomes and improving nutrition in relatively short time frames. Sweetpotato and other root crops are major staples for Papua New Guinea and Pacific island countries, while potato demand is increasing rapidly in countries such as Indonesia. Short crop cycles for most vegetables provide opportunities for rapid adoption of technology and enable increased returns from limited land areas. **Ornamental crops** are becoming increasingly important for income generation in developing countries, and may be particularly important in Pacific island countries where small domestic markets and high transport costs may limit the options for other horticultural crops. 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 is integrated into the Horticulture, Agribusiness and Pacific Crops programs and will have four focus areas:

- a systems approach to improving pre-harvest crop productivity including integrated management of pests and diseases, paying attention to crop health and links with soil fertility;
- biological control, incorporating the use of environmentally friendly approaches to pest, disease and weed control (including the use of soft chemicals and biocontrol strategies);
- postharvest handling and disinfestation treatments; and
- improvements in biosecurity including application of diagnostics, pest and disease surveys, and surveillance and assessment of the quarantine risk of specific horticultural and plantation crops.

Plantation crops

Australia has less 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, Pacific islands and Indonesia is significant. However, Australia has substantial expertise in agronomic principles; crop protection; harvesting; postharvest; extraction technologies; and social and economic issues including the integration of these disciplines. Where the necessary expertise is not available in Australia, ACIAR gains access to this know-how through partnerships with appropriate international organisations. ACIAR will especially encourage linkages with private sector and industry organisations, as well as research providers, to identify quality factors that can be targeted for improvement to increase grower incomes through analysis of production and marketing chains. It will also identify the social and economic incentives necessary to encourage adoption of high-value production or processing systems, and undertake research to improve quality, recovery and yield.

Crop pest and disease management

ACIAR emphasises sustainable management of pests in crops where losses are significant and for which standard chemical solutions may be either limited in effectiveness, environmentally unsuitable or uneconomic for developing-country smallholders. Recognising that one of the constraints to adoption of integrated pest management is the complexity of the approach and the subsequent high level of training needed for farmers, better methods of participatory research and information dissemination will be supported. ACIAR will focus collaborative biocontrol research projects in South-East Asia, Papua New Guinea and the South Pacific, where many pests not native to these regions are ideal targets for classical biological control. Initiatives include: identification of target pests, weeds and diseases where there is immediate availability of control agents; advice on safe operations in relation to quarantine and host-specificity testing; development of novel methods of mass-propagation of natural enemies for inundative release; and strategies for effective field application to achieve ongoing control. For some pests in certain environments,

biocontrol methods have become routine, and technology application rather than research is required. Work on non-chemical approaches to pest and disease management will gain special importance when linked to organic or other forms of certification that add further value to products.

Animal health and production

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

The animal health program has a major focus on the following diseases of regional significance:

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

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

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

Ruminant nutrition and husbandry

In most smallholder livestock production systems in the tropics and subtropics, poor nutrition is the major constraint to the growth, milk or wool production, fertility and reproductive performance of ruminants. The key problems are quality and availability of feeds throughout the year and inefficient use of 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 fertility and reproductive performance can be redressed—partly by improved nutrition and disease control, and in some situations by managing the mating (and therefore calving) period and by strategic management of the offspring. In all these situations social and economic issues play an important role in determining whether such options are appropriate.

Optimising crop-livestock systems

Most livestock (e.g. small and large ruminants, pigs and poultry) are integral components of complex crop-livestock systems. A significant proportion of the feed for these livestock is provided by the crops (grains and tubers, stover, green forage and by-products from processing), along with weeds from within and around the crops. Appropriate management of livestock manures can significantly improve crop production and help maintain soil conditions, while reducing risks of contaminating water supplies. Building a better understanding of the biological, social and economic aspects of these systems is necessary when determining intervention points and developing appropriate technologies for smallholder farmers. A priority for future work includes the development of optimisation protocols for balancing the forage, crop, livestock, human capital and environmental components of systems. ACIAR has invested in the assembly of current knowledge on forage production, and the distribution and use of this information is a continuing emphasis.

Smallholder dairy

The focus for collaborative research in dairy is on the temperate and subtropical regions of South Asia (currently Pakistan), where dairy products are a major source of dietary protein and where smallholder producers have access

to markets for their products. ACIAR does not support dairy research projects in the tropical countries of South-East Asia because these regions do not have a comparative advantage in dairy cattle production, and because more open international trade allows countries to emphasise their areas of comparative production and marketing. Emphasis is placed on researchable production constraints of these often mixed livestock–crop production systems, including improved feed use and quality, and changes in cropping systems to include higher quality feeds and supplements. Integrated approaches, involving 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 priorities.

Pigs and poultry

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

Genetic improvement

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

Capture fishery resource assessment and management

ACIAR fosters a precautionary approach to wild fisheries resource management, and retains a clear focus on small-scale fishers and farmers. The emphasis is on assessment and management for sustainability of wild-harvest fisheries, including conservation and rehabilitation of the critical habitats that support them. Australia shares responsibilities with Papua New Guinea and Indonesia to sustainably manage cross-boundary fish stocks in the Torres Strait and Arafura Sea. Cooperative research on shared stocks can deliver strong mutual benefits for these resources, while providing the opportunity to enhance the capacity of partner countries to assess and better manage all exploited stocks, domestic as well as international. Illegal, unregulated

and unreported (IUU) fishing is a major contributor to rapidly declining harvests from many wild-capture fisheries, with the situation particularly acute in Asia. As Australia is a leading participant in ongoing international efforts to combat this problem, it remains an area of active involvement for ACIAR.

Research areas of emphasis include:

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

Sustainable production of culture fisheries

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

- **domestication and breed improvement** of new and common species where these factors constrain sustainable and profitable aquaculture operations
- **improved nutrition**, better use of on-farm feed sources and development of cost-effective feed formulations, with emphasis on the reduced use of fish products, encouragement of low-polluting formulations and better feeding strategies
- the **diagnosis, control and management of aquatic diseases** as major threats to the long-term viability of intensive aquaculture, with particular emphasis on management of shrimp disease in smallholder systems and viral diseases in finfish
- **culture-based fisheries in inland water bodies** and the integration of aquaculture into existing small-scale farming systems. There is an increased emphasis on freshwater aquaculture in Papua New Guinea and the South Pacific, and a continued emphasis in some 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
- **the reduction of adverse environmental impacts of and on aquaculture.**

Forestry

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

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

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

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

Appendix 1b: Cross-cutting issues to be addressed in 2009–10

Climate change

Agriculture depends on the sustainable use of natural resources and, for this reason, will be more directly and significantly affected by climate change than other sectors of the economy. Agriculture is also a significant contributor to climate change. **Developing countries are more likely to be affected by climate change** because they rely more on agriculture for employment and contribution to their economies.

The impact of climate change on agriculture is likely to include shifts in rainfall patterns, increases in temperatures that change agro-ecological systems, and may facilitate the spread of diseases, pests and weeds beyond their current areas. Understanding the consequences of such changes on agricultural systems and managing these changes through mitigation and adaptation will be vital to ensuring agricultural productivity does not fall.

ACIAR has a history of commissioning projects that are designed to introduce and manage changes to agricultural systems, to help those systems become more productive and resilient. The lessons learned from these projects have been incorporated into a suite of recent projects addressing adaptation to and mitigation of climate change. At the heart of these projects is an understanding of the agro-ecological conditions on which these systems rely. This knowledge is being used in the design of new projects specifically addressing climate change including those in the **new climate change program in South Asia and South-East Asia**, and in projects building more resilient systems that will be better placed to adapt to potential changes.

The focus on ACIAR's future climate change research will be on **managing the impacts of climate change in specific regions**, and on assisting the sustainable management of agricultural systems in variable climates, continuing past work in this area. Projects that address **sustainability**, such as water management, soil and crop management and land use and natural resource management, particularly in marginal areas, address climate change indirectly. Policy issues will also be included, either within projects or where warranted as projects in their own right.

Quarantine and biosecurity

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

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

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

ACIAR also supports work on **policy issues** in the regulatory and institutional framework on agricultural health, food safety and quality assurance systems. This is very relevant for international market access, cross-border and domestic trade, and public health. Gaps between individual national and international sanitary and phytosanitary standards and regulations need to be rectified, as well as gaps between regulatory principles and implementation in practice. 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 as well as

research designed in the context of a systems approach to conservation agriculture. Where appropriate, biophysical experimentation is closely integrated with economics and policy research, using economic instruments and institutional improvements from local to national levels for efficient management of natural resources.

Agricultural water management research focuses on improving irrigation water-use efficiency in arid climates, particularly in well-endowed areas of the Indo-Gangetic Plains. There is also a selective investment in water management for agriculture in more humid countries of South-East Asia such as Vietnam and the Philippines. Application of existing knowledge on irrigation water scheduling and irrigation hardware and software to reduce excessive irrigation is also important. Demand management (including water pricing and related subjects) is a priority, as are improved institutional arrangements for managing irrigation systems and groundwater use.

Research on agricultural land management in the less favourable areas of Asia is directed to particular problem areas identified by our partner countries in the rainfed cropping systems of China, the Mekong Basin and South Asia. It ranges from supporting crop diversification and water harvesting in infertile rainfed areas to improving sustained production from marginal upland and sandy coastal areas. On sloping marginal lands, technical research projects on upland land management and soil conservation will continue, but there will be greater emphasis on economic and institutional issues and constraints to the adoption of proven technologies. It will also highlight the importance of cash incomes and food security for those working steep lands. More projects will involve research on integrated management of water and soil resources at the catchment level, and will be designed to enable 'scaling out'.

Some work on **soil, water and crop contamination** will continue, although with decreased emphasis. Priority will be given to research on management of wastes arising from agricultural industries including intensive livestock operations, and to reclamation of wastewaters for agricultural production. For protection of water quality, ACIAR will emphasise an integrated catchment approach, with particular attention to maintaining profitable agricultural activities that also protect off-site surface water and groundwater quality. Other research will involve production systems and integrated pest management strategies that minimise the use of chemical pesticides and opportunities for converting processing residues into useful products such as organic soil amendments.

Agricultural policy, marketing and farming systems research

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

- **agricultural industry and trade policy**, with commodity- or industry-specific studies to assess policy requirements for improved access for smallholders into developing markets. This includes local and national structural adjustment (rural transformation) to support agricultural diversification, including the assessment of policy requirements to achieve production change and meet market requirements
- **natural resource management economic policy**, with a focus on water resources, particularly institutional policies to promote equitable and efficient use of surface water and groundwater resources. Other issues include: management of both community resources and those under common title/or access, including common grazing lands, rangelands, fishery stocks and forests; and research on how to involve resource users and stakeholders in designing and implementing resource management
- **rural development policy**, including analysis of structural adjustment following trade liberalisation, cooperative arrangements and the role of social capital in successful rural institutions. ACIAR will foster policy research on institutional adjustments that will improve links between farmers and markets, including 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**, including the study of extension systems, and documenting and trialling new methodologies, both at the district and system-wide levels
- **research into marketing systems** to seek efficiencies post farm-gate and/or link on-farm production decisions to subsequent post-farm-gate activities
- **systems modelling for variable environments**, involving an essential thorough understanding of the climatic, biophysical and socio-economic conditions that make up farming systems. Specific priorities for research include: enhancement of components of the models to specific developing-country farming systems; development of information in a form that encourages dialogue between farmers and extension or research workers; consideration of the long-term effects of changes (e.g. climate change) to farming systems; and consideration of enterprise mixes (e.g. crops and livestock) to reduce the risk to income, assets and food security as well as improve income generation and support sustainability of the natural resources.

Agribusiness

ACIAR undertakes agribusiness research across a number of its programs. It focuses on issues that can improve conditions for smallholders and increase value chain efficiency. Research supported by the program has a market-driven focus, and researchers gauge the impacts of technical and regulatory interventions throughout the value chain.

The agribusiness program will contribute to:

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

Appendix 1c: Country focus for ACIAR's R&D programs in 2009–10

Crops cluster

- **Crop Improvement and Management (CIM)** research is in China, India and Bangladesh where many of the production constraints are similar to those in Australia; in East Timor, Iraq and Afghanistan where introduction of improved staple crops can assist food security and technical cooperation is critical to improved local capacity. The program includes strong collaboration with several CGIAR centres
- The **Cropping Systems and Economics (CSE)** program focuses on Cambodia, Lao PDR, India and Bangladesh, and during 2009–10 is anticipated to include some activities in Africa
- The **Pacific Crops (PC)** program aims to improve the productivity, profitability and sustainability of horticultural, root and tree crop-based farming systems in Papua New Guinea and selected Pacific island countries. It has a multidisciplinary emphasis on integrated crop management, including crop production, protection, postharvest handling and marketing
- **Horticulture (HORT)** research is in the Philippines, Indonesia and Vietnam (through the ACIAR Agribusiness program) where market access and quality are of high priority; and in Pakistan, Cambodia and the Pacific islands (through the ACIAR Pacific Crops program), where improving productivity and quality management in horticultural and tree crops represents significant opportunities to lift smallholder incomes.

Livestock and fisheries cluster

- Research on **Livestock Production Systems (LPS)** focuses on ruminant nutrition and husbandry and on optimising crop–livestock systems. A limited amount of research on monogastric livestock is supported where the target groups are linked to markets. Countries involved include Indonesia, Vietnam, Pakistan, the Republic of South Africa and some parts of western China
- The **Animal Health (AH)** program primarily works in Indonesia, Lao PDR and Cambodia, with a focus on trans-boundary and zoonotic diseases that affect productivity and marketability. Small programs are managed in Papua New Guinea and the Philippines
- The **Fisheries (FIS)** program has a geographic focus on island countries such as Papua New Guinea, the Pacific island countries, Indonesia and the Philippines, as well as selectively complementing other donor programs in Mekong countries such as Lao PDR and Vietnam.

Natural resource management cluster

- The **Forestry (FST)** program seeks to work in countries where there is a significant competitive advantage with respect to forestry, such as suitable climate and land, and people skilled in growing trees. These include Papua New Guinea, some Pacific island countries, Indonesia, Vietnam and Lao PDR
- The **Land and Water Resources (LWR)** program emphasises agricultural land and water management and climate change adaptation in China, India, Pakistan, Lao PDR and Cambodia. In the more marginal regions of Bangladesh and India, emphasis will be on improving livelihoods through improving water resource management in dryland and irrigated agriculture
- The **Soil Management and Crop Nutrition (SMCN)** program focuses on wetter countries, including Papua New Guinea, the Philippines, Vietnam and Burma, where researchers confront issues such as soil management and fertility as well as seasonal water scarcity. Another focus is post-tsunami land rehabilitation in Indonesia.

Economics and social sciences cluster

- The **Agricultural Development Policy (ADP)** program research is focused on China, Indonesia and India
- The **Agricultural Systems Management (ASEM)** program particularly addresses problems in Papua New Guinea, the Philippines, Lao PDR and Cambodia
- **Agribusiness** development is of key importance in several countries. Within Indonesia, Vietnam and the Pacific island countries it is managed by the ACIAR Agribusiness (AGB) program, while a range of programs manage agribusiness projects in other countries.

Summary: Country by research program matrix for new project development

| Country/region | Economics and social sciences cluster | | | | Crops cluster | | | | Natural resources management cluster | | | | Livestock cluster | | | |
|--------------------------|---------------------------------------|------|-----|--|---------------|-----|----|------|--------------------------------------|------|-----|----|-------------------|-----|--|--|
| | ADP | ASEM | AGB | | CIM | CSE | PC | HORT | LWR | SMCN | FST | AH | LPS | FIS | | |
| Papua New Guinea | | | | | | | | | | | | | | | | |
| Pacific island countries | | | | | | | | | | | | | | | | |
| Indonesia | | | | | | | | | | | | | | | | |
| Philippines | | | | | | | | | | | | | | | | |
| East Timor | | | | | | | | | | | | | | | | |
| Vietnam | | | | | | | | | | | | | | | | |
| Cambodia | | | | | | | | | | | | | | | | |
| Lao PDR | | | | | | | | | | | | | | | | |
| Burma | | | | | | | | | | | | | | | | |
| China | | | | | | | | | | | | | | | | |
| India | | | | | | | | | | | | | | | | |
| Pakistan | | | | | | | | | | | | | | | | |
| Bangladesh | | | | | | | | | | | | | | | | |
| Other South Asia/ Iraq | | | | | | | | | | | | | | | | |
| South Africa | | | | | | | | | | | | | | | | |
| Other Africa | | | | | | | | | | | | | | | | |

Special initiatives only

Developing new projects

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

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

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

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

This plan outlines indicative priorities by program and country. These priorities have been drawn up to focus projects on specific topic areas. ACIAR expects this focus to result in more projects that take research outputs through to a pilot extension phase in which end users are directly involved. To support this change, ACIAR is developing more partnerships that involve private sector extension agencies, the commercial sector, NGOs, government extension agencies and 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, often involving a suite of scoping studies commissioned by ACIAR as 'small research activities'.

Consideration of the expected time to impact for new project proposals

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

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

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

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

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

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

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

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

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

Scoping of relevant R&D activities

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

Capturing data on project impacts more broadly and more regularly

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

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

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

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

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

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

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

companies may achieve greater consistency and quality of raw material supply.

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

Further details on engaging with ACIAR are available through the ACIAR website under 'Project Development Guidelines'.

Appendix 2: Benefits to Australia

ACIAR provides a unique interface between two very important parts of the Australian economic and social environment. It integrates foreign aid policy with the Australian innovation system to provide mutual benefits to poorer nations in our region and to Australia. The benefits for Australia stem indirectly from the strengthened international relations and enhanced capacity of Australian agricultural researchers, and directly from increased productivity of Australian farmers and management of biosecurity threats.

As mutual benefit is an important selection criterion for all ACIAR-funded projects, most projects involve research that is expected to generate significant direct benefits to Australian agriculture. Impact assessments from past ACIAR-funded projects provide evidence that this is the case. Of the total impact benefits of around \$10 billion (in 2008 dollars), over \$900 million has accrued to Australia.

In addition to evidence from past projects, the description below provides examples of current ACIAR projects that are expected to result in a stream of benefits to Australia (as well as our partner countries) in the future.

Examples of current projects with expected Australian benefits

Improving biosecurity and surveillance of exotic animal diseases

The ongoing effort to keep Australia free from exotic diseases such as avian influenza and foot-and-mouth disease (FMD) is underpinned by improved understanding of disease transmission in neighbouring countries, better control policies, and better surveillance systems that extend into northern Australia. For example, reduced disease risk for Australia results from reduced disease risk in Indonesia, and projects in that country are designed to strengthen the surveillance capacity of Indonesian authorities to detect FMD (AH/2004/020, 'Appropriate methods of disease surveillance for major trans-boundary diseases') and better understand the role of ducks in the spread of avian influenza (AH/2004/040, 'Epidemiology and control of avian influenza in ducks'). Another project (AH/2006/169, 'Biosecurity in non-industrial commercial poultry production') has established a multi-stakeholder forum to develop new biosecurity policies for commercial and smallholder poultry enterprises. Also under development for Papua New Guinea (PNG) and Cape York are new surveillance systems that involve local communities in the detection and reporting of sick animals (AH/2006/157, 'Development of animal health surveillance systems'). A further project (AH/2008/037, 'Assessment of the potential

economic impacts of the *Varroa* bee mite on the pollination of major crops') is assessing the potential of the bee mite *Varroa* to reduce the pollination of PNG's cash crops, while also contributing to biosecurity plans to prevent the mite's incursion into Australia.

Improved management practices for profitable cropping systems

Research on the south central coast of Vietnam and also in Western Australia is evaluating technologies and practices for more sustainable and profitable farming systems. Both regions have similar challenging environments (poor, sandy soils under water-limiting conditions). The approach taken in the project (SMCN/2007/109, 'Sustainable and profitable crop and livestock systems for south-central coastal Vietnam') is to determine how a range of land uses and soil amendments, and the characteristics of different sandy soils, affect soil organic matter across a diverse range of locations in south-western Australia. These variations in soil organic matter will be used to determine water- and nutrient-use efficiency and to identify promising farming practices best suited to local conditions. The integrated farming systems approach that will be deployed is broadly applicable to mixed grain-grazing enterprises in Australia and the research will specifically address critical constraints to cattle production and profitability. Additional research on manure management will help to reduce nutrient losses and improve soil fertility. As well, an agribusiness component will analyse value chains in an effort to make Australian produce more competitive in both domestic and export markets. Australian vegetable producers have struggled in international markets over the past six years, with an export decline from \$352 million in 2001–02 to \$178 million in 2007–08. Focusing on supply chains for important Australian vegetables such as broccoli, lettuce, celery, melons, sweet corn and hydroponic tomatoes, the agribusiness component will recommend more appropriate intervention strategies.

Development of a teak plantation industry in northern Australia

In recent years a strong commercial interest has developed in the establishment of plantations of high-value hardwood timbers in northern Australia. Prominent among these hardwood species is teak. A current project (FST/2007/020, 'Improving silvicultural and economic outcomes for community timber plantations in Solomon Islands by interplanting with teak (*Flueggea flexuosa*) and other Pacific agroforestry species') will assist Australian industry by identifying optimal silvicultural practices. Detailed studies of the timber properties of young teak will lead to shorter

planting rotations, with a consequent improvement in profitability. Significant Australian industry co-funding is indicative of the strong interest in this species. Another project under development (FST/2008/050, 'International assembly and testing of teak germplasm') is intended to provide essential underpinning for teak breeding programs.

The expansion of sandalwood as a high-value crop in Australia

Sandalwood commands a very high price on the international market. At present about 95% of the global supply is from India, but it has been predicted that overexploitation will see existing stands close to extinction by 2020. Thus there is an opportunity for plantation-based production. Australian investment companies have grasped this opportunity and have now established some 3,000 ha in Western Australia. The scarcity of suitable land and availability of water are likely to restrict further expansion in this state, and current industry initiatives are looking to Queensland for growth. A previous ACIAR project (FST/2002/097, 'Identification of optimum genetic resources for establishment of local species of sandalwood for plantations and agro-forests in Vanuatu and Cape York Peninsula') identified populations of the native Queensland sandalwood that will meet the highest international standards. A project under development (FST/2008/010, 'Development and delivery of germplasm for sandalwood and whitewood in Vanuatu') will contribute to the further growth of the Queensland industry by establishing the basic elements of a breeding program for Queensland sandalwood. In particular, the work will involve an indigenous Cape York community as a partner.

The development of a high-value wood products industry based on plantation eucalypts

The eucalypt plantation estate in Australia now comprises almost 900,000 ha. Although this estate was largely established for the production of pulpwood, there is an increasing interest in using plantation eucalypts for the production of higher value products traditionally produced from native forest eucalypts. A major driver for this has been the progressive closure of native forests to logging activities. Two recently completed ACIAR projects (FST/1995/095, 'Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: Genetics and silviculture' and FST/2001/021, 'Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying') applied silvicultural, genetic and technological approaches in an effort to solve the problems encountered in producing sawn timber from young plantation eucalypts. Another current project (FST/2008/039, 'Enhancement of production of acacia and eucalypt peeled and sliced veneer products in Vietnam and Australia') aims to produce high-quality veneers from plantation eucalypts and acacias.

Improving the livelihoods of farmers and other participants in the potato and sweetpotato supply chains

Focusing on potato in Australia and sweetpotato in PNG a project (ASEM/2006/035, 'Improving marketing efficiency, postharvest management and value addition of sweetpotato in PNG') has sought to improve their respective supply chains. The Australian component focuses on enhanced supply-chain management and reduced postharvest losses in potatoes (fresh, seed and potatoes for processing). The Australian potato industry produces 1.3 million tonnes per year, and is valued at \$480 million. By contrast with other vegetable crops, the Australian potato industry has seen increased exports in recent years to its key markets in Asia, but at times they experience excessive losses due to postharvest rots and breakdown. Analysis of the Australian supply chain should identify practices that may contribute to these losses. Another facet of the Australian component is to improve control of postharvest diseases through the application of both conventional and new measures, such as biocontrol methods and essential oils. These alternatives may be more acceptable to consumers who are increasingly averse to postharvest chemical usage.

Better summer cropping in north-eastern Australia

A project (ASEM/2006/130, 'Enhancing production and marketing of maize and soybean in north-western Cambodia and production of summer crops in north-eastern Australia') seeks to reduce the impact of climate variability and climate change on farm families in north-western New South Wales (NSW). Using whole-farm models and studying the social networks that influence farm practice change, the project focuses on adoption of conservation farming practices. The problem targeted in north-western NSW is lack of adoption of no-tillage and conservation farming practices—there has been only a 50% take-up of no-tillage cropping systems. Adoption of these practices is seen as a key strategy for adaptation to climate variability and climate change. The crops studied in Australia will be sorghum, maize and sunflower.

Better quality mangoes

Through better plant nutrition management for pest and disease control and improved postharvest storage and handling, better mango quality is promised. Earlier ACIAR projects significantly increased the understanding of mango physiology—especially the relationship between plant nutrition and pest and disease management, but also with respect to fruit post-harvest handling and storage of fruit and therefore quality for consumers. The latter is especially important for improved access to export markets but it is also significant for improved quality for Australian consumers, given the long distances mangoes are transported domestically. A set of five projects is making use of the earlier research outcomes to develop simple management options and technologies for application in a range of conditions. The projects are:

- HORT/2005/157 ('Optimising mango supply chains for more profitable horticultural agri-enterprises in Pakistan and Australia');
- HORT/2005/153 ('Development of integrated crop management practices to increase sustainable yield and quality of mangoes in Pakistan and Australia');
- HORT/2006/146 ('Management of fruit quality and pest infestation in mango and mangosteen to meet technical market access requirements');
- HORT/2007/067 ('Improved domestic profitability and export market competitiveness of selected fruit value chains in the southern Philippines and Australia');
- SMAR/2007/193 ('Quality management to enhance effective supply chains for mangoes and rambutans in Nusa Tenggara Barat (NTB), Indonesia').

For Australia, significant adoption of an integrated package for management and application is expected during the next few years with substantial benefits to Australian mango growers and consumers.

Improved fruit fly management and incursion risk reduction

Fruit fly taxonomy and control has been a major focus for ACIAR and its partners, with significant gains already achieved. Two projects (HORT/2003/036, 'Managing pest fruit flies to enhance quarantine services and upgrade fruit and vegetable production in Indonesia' and HORT/2008/041, 'Development of strategies for wide-area fruit fly management in Indonesia and Australia') are continuing to address this important area, and will generate future improvements in management options for Australian farmers. They will also reduce the risk of incursion from countries in the region through better understanding of damaging species, better control in partner countries and improved quarantine measures.

Implementation of low-cost, sustainable vegetable production strategies

Research under way in the Philippines and Cambodia aims to develop low-cost but sustainable strategies for the production of high-quality intensive vegetables. These strategies address a range of issues that are common to Australian growers – including bacterial diseases of solanaceous crops (e.g. tomato and potato), production and use of organic mulches, and development of low-cost structures to protect cropping of high-value vegetables. Technologies from the Cambodian vegetable project (HORT/2006/107, 'Sustainable vegetable value chains for Cambodia') are particularly relevant to the relatively large population of growers from Cambodia now living in the Sydney Basin. As well, the low-cost protected cropping structures being developed in the Philippines (HORT/2007/066, 'Enhanced profitability of selected vegetable value chains in the southern Philippines and Australia') have potential use under Australian conditions. They could benefit the production of organic vegetables through pest and disease exclusion, and also the production

of high-quality specialist vegetables through shelter from rainfall and high winds.

Equitable water allocation

Watershed Development (WSD) programs in rainfed dryland agriculture in India are contributing to the sustainability of the surface water and groundwater resources, and improving the livelihoods of farmers. These programs have been applied at the micro-catchment or village level (up to 500 ha). While there has been some evaluation of these programs, the question remains on the level of return in relation to investment at meso-basin levels (around 5000 ha). Water retention or groundwater pumping in one locality may negatively affect access to water or water management, generally at a larger scale, but this may be difficult to detect at a micro level. Similar issues occur in Australia, albeit at a different geographical scale, where changes in climate and a realisation that water may have been over-allocated have challenged researchers trying to gain positive economic, social and equity outcomes, particularly in irrigation areas. One project (LWR/2003/026, 'Water allocation in the Krishna River Basin to improve water productivity in agriculture') aims to quantify the aggregated impact of watershed interventions on hydrology within and across watersheds at the meso-scale. Researchers are developing and applying integrated models to assess cost-effectiveness and water-related equity outcomes of stakeholder-defined watershed development scenarios. The aim is to integrate and (through partners) apply the knowledge arising from the project at the local, state and national policy levels in both India and Australia.

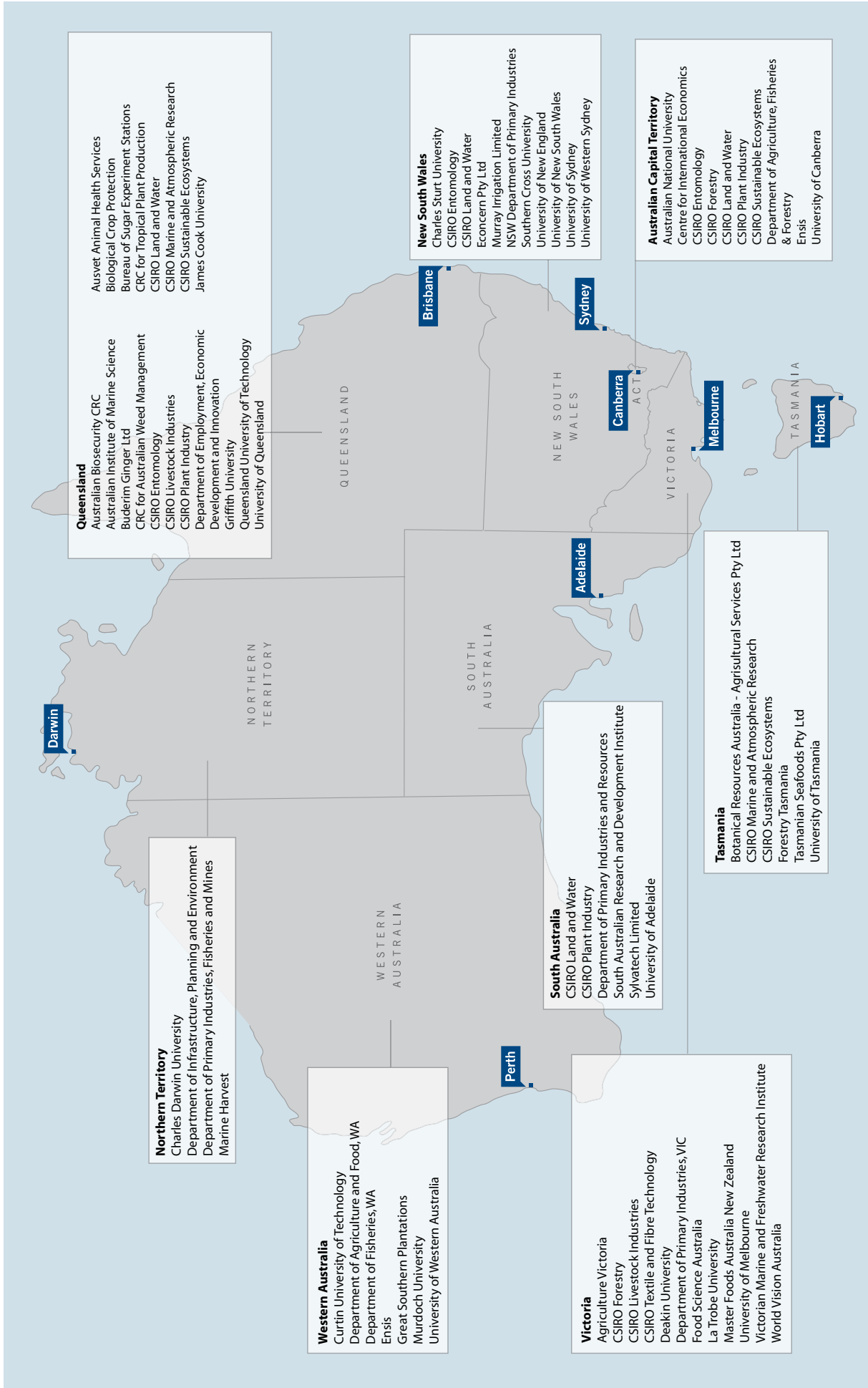
Better management of pulses in Australian cropping systems

Australia is the largest exporter of pulses (edible legume seeds) in the world, with most exports targeted towards Asian markets. In Queensland, peanut and soybean are major rotation crops in sugarcane farming systems, while mungbean and chickpea are grown widely as rotation crops in cereal-based cropping systems. These pulse crops play an important role in breaking disease and pest cycles in the crop cycle, and improving soil fertility. Typically, pulses grown in rotation can lift yields of sugarcane by 30% and protein in cereal crops by 0.5–1.8%. But poor establishment of soybean and peanut in coastal cane farming systems, and lack of defined management for new mungbean varieties in cereal cropping systems, are limiting the potential impacts of these pulse rotations. With increasing prices of nitrogen fertilisers, growers report that the losses due to poor pulse crop establishment can be substantial when yield losses (up to 40%), additional costs of fertilisers (to overcome the poor growth) and loss of nitrogen for the subsequent cane crops are aggregated. Project SMAR/2007/068 ('Productivity and profitability enhancement of tropical pulses in Indonesia and Australia') is addressing these issues—through on-farm trials to better understand and improve nitrogen fixation of soybean and peanut in coastal cane soils, and through adaptive trials to develop effective management practices for better yields of mungbean in cereal crop rotations.

Reducing greenhouse gas emissions from livestock production on grasslands

Both Australia and China have about 400 million ha of grasslands to provide the feed resource for major livestock industries. Much of the grassland resource in both countries is degraded due to over-grazing. In Australia, however, grassland management has generally improved in the past two decades, resulting from industry restructuring, strong market forces and the adoption of science-based management strategies that emphasise production efficiency (per animal) and long-term sustainability. Over the same period, grassland degradation has increased in China as stock numbers (and stocking rates) have risen and individual animal performance has declined, with more kilograms (kg) of feed consumed to produce one kg of product (milk, meat, wool) and, consequently, more kg of methane produced per kg of animal product. At the same time, loss of ground cover and soil fertility leads to depleted soil organic matter and greater contribution of CO₂ to the atmosphere. The solutions to the problem of grassland degradation and associated greenhouse gas emissions lie in shifting the emphasis of livestock systems towards production efficiency per animal. Project (LPS/2001/094, 'Redesigning grassland livestock systems to significantly reduce greenhouse gas emissions') uses modelling, policy analysis and on-farm data collection to estimate the methane mitigation resulting from grassland management policies and sustainable management options. Australia, by helping China address its more serious problems, is developing better judgment on improved management of its own options, particularly in extensive grassland systems.

Australian Project Partners in 2009–10



Appendix 3: Selected world development indicators

| | Adult illiteracy (% of those aged over 15 years) ^a | Employment in agriculture (%) ^a | GDP (US\$ billion) ^a | GDP growth annual (%) ^a | GDP per capita (US\$) ^a | Human development index (ranking out of 177 countries) ^a | Human poverty index (ranking out of 103 countries) ^a | Internet users (1,000s) ^a | Agricultural land as % of land area ^a | Life expectancy at birth (years) ^a | Official development assistance— current (US\$ million) ^a | Population (millions) ^a | Population (rural) as % of total ^b | Population growth rate (%) ^a | Telephone mainlines per 1,000 people ^a | Population using an improved water source (%) ^a |
|--|---|---|------------------------------------|---------------------------------------|---------------------------------------|--|--|---|---|---|--|---------------------------------------|--|--|--|--|
| Papua New Guinea and Pacific island countries | | | | | | | | | | | | | | | | |
| PNG | 42.7 | 72 | 4.9 | 6.2 | 953 | 145 | 90 | 23 | 2 | 59.6 | 266.1 | 6.5 | 88 | 2.0 | 11 | 39 |
| Fiji | 5.6 | .. | 2.7 | -3.9 | 4,014 | 92 | 50 | 77 | 25 | 68.3 | 6.4 | 0.8 | 48 | 0.6 | 122 | 47 |
| Solomon Islands | 23.4 | .. | 0.3 | 6.3 | 978 | 129 | 53 | 8 | 4 | 63.0 | 198.2 | 0.5 | 82 | 2.3 | 16 | 70 |
| Vanuatu | 26.0 | .. | .. | 4.7 | 1,995 | 120 | 56 | 38 | 12 | 69.3 | 39.5 | 0.2 | 75 | 2.4 | 33 | 60 |
| Samoa | 1.4 | .. | 0.4 | 4.7 | 2,750 | 77 | .. | 32 | 46 | 70.8 | 44.0 | 0.2 | 77 | 0.9 | 73 | 88 |
| Tonga | 1.1 | .. | 0.2 | -3.5 | 2,470 | 55 | .. | 29 | 42 | 72.8 | 31.8 | 0.1 | 75 | 0.5 | .. | 100 |
| Kiribati | .. | .. | .. | 2.0 | 762 | .. | .. | .. | 51 | .. | .. | 0.1 | 56 | 1.6 | .. | .. |
| South-East Asia | | | | | | | | | | | | | | | | |
| Indonesia | 9.6 | 44 | 287.2 | 6.3 | 1,869 | 107 | 47 | 73 | 26 | 69.7 | 2,523.5 | 234.3 | 48 | 1.2 | 58 | 77 |
| Vietnam | 9.7 | 58 | 52.4 | 8.3 | 815 | 105 | 36 | 129 | 31 | 73.7 | 1,904.9 | 88.5 | 72 | 1.3 | 191 | 85 |
| Philippines | 7.4 | 37 | 99.0 | 7.3 | 1,639 | 90 | 37 | 54 | 41 | 71.0 | 561.8 | 89.7 | 35 | 1.9 | 41 | 85 |
| Cambodia | 26.4 | 70 | 6.2 | 10.2 | 598 | 131 | 85 | 3 | 30 | 58.0 | 537.8 | 14.7 | 78 | 1.7 | 3 | 41 |
| Lao PDR | 31.3 | 85 | 2.9 | 8.0 | 711 | 130 | 70 | 4 | 8 | 63.2 | 295.7 | 5.0 | 69 | 1.7 | 13 | 51 |
| East Timor | 49.9 | .. | 0.3 | 16.2 | 393 | 150 | 95 | .. | 23 | 59.7 | 184.7 | 1.2 | 73 | 3.5 | .. | 58 |
| Thailand | 7.4 | 43 | 176.6 | 4.8 | 3,841 | 78 | 24 | 110 | 36 | 69.6 | -171.1 | 64.3 | 67 | 0.7 | 110 | 99 |
| Burma | 10.1 | 63 | .. | 5.5 | 379 | 132 | 52 | 2 | 17 | 60.8 | 144.7 | 49.2 | 67 | 0.9 | 9 | 78 |
| South Asia and Middle East | | | | | | | | | | | | | | | | |
| India | 39.0 | 67 | 805.7 | 8.7 | 976 | 128 | 62 | 55 | 61 | 63.7 | 1,724.1 | 1,186.2 | 71 | 1.5 | 45 | 86 |
| Pakistan | 50.1 | 42 | 110.7 | 6.0 | 996 | 136 | 77 | 67 | 35 | 64.6 | 1,666.5 | 167.0 | 64 | 1.8 | 34 | 91 |
| Bangladesh | 52.5 | 52 | 60.0 | 6.5 | 428 | 140 | 93 | 3 | 69 | 63.1 | 1,320.5 | 161.3 | 73 | 1.7 | 8 | 74 |
| Bhutan | 53.0 | .. | 0.8 | 22.4 | 1,982 | 133 | 86 | 39 | 13 | 64.7 | 90.0 | 0.7 | 65 | 1.4 | 51 | 62 |
| Afghanistan | .. | .. | 8.0 | 12.4 | 345 | .. | .. | .. | 58 | 42.9 | .. | 28.2 | 76 | 3.9 | .. | 39 |
| Iraq | .. | .. | 13.0 | 2.8 | 2,404 | .. | .. | .. | 23 | 57.7 | .. | 29.5 | 33 | 1.8 | .. | 81 |
| North Asia | | | | | | | | | | | | | | | | |
| China | 9.1 | 44 | 2,234.3 | 11.4 | 2,604 | 81 | 29 | 85 | 59 | 72.5 | 1,756.9 | 1,336.3 | 57 | 0.6 | 269 | 77 |
| Southern Africa | | | | | | | | | | | | | | | | |
| South Africa | 17.6 | 10 | 239.5 | 5.1 | 5,826 | 121 | 55 | 109 | 82 | 50.8 | 700.0 | 48.8 | 39 | 0.6 | 101 | 88 |
| Ethiopia | 35.9 | 93 | 11.2 | 11.2 | 201 | 169 | 169 | 2 | 32 | 51.8 | 1,937.3 | 85.2 | 83 | 2.5 | 9 | 22 |
| Kenya | 73.6 | 19 | 18.7 | 7.0 | 786 | 148 | 148 | 32 | .. | 52.1 | 7,68.3 | 38.6 | 78 | 2.7 | 8 | 61 |
| Tanzania | 69.4 | 82 | 28.5 | 7.3 | 368 | 159 | 159 | 9 | 54 | 51.0 | 1,505.1 | 41.5 | 75 | 2.5 | 4 | 62 |
| Mozambique | 38.7 | .. | 6.6 | 7 | 362 | 172 | 172 | 7 | 62 | 42.8 | 1,285.9 | 21.8 | 63 | 1.9 | 4 | 43 |
| Zimbabwe | 89.4 | .. | 3.4 | -6.1 | 159 | 151 | 151 | 77 | 53 | 40.9 | 367.7 | 13.5 | 63 | 1.0 | 25 | 81 |

^a United Nations Development Program, Human Development Report 2007–2008 Online. <http://hdr.undp.org/en/media/hdr_20072008_en_complete.pdf> accessed 8 April 2009

^b United Nations Statistics Division Online 2009, selected data from 2007 and 2008. <<http://nsd.un.org/unsd/demographic/products/socind/>> accessed 8 April 2009

^c The World Bank, Data and Statistics. <<http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS>> accessed 29 April 2009

Selected world development indicators: definitions and metadata

Adult illiteracy: calculated as 100 minus the adult literacy rate.

Employment in agriculture: employment in industry, agriculture or services as defined according to the International Standard Industrial Classification (ISIC) system (revisions 2 and 3). 'Agriculture' refers to activities in agriculture, hunting, forestry and fishing.

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

GDP annual growth rate: least squares annual growth rate, calculated from constant price GDP in local currency units.

GDP per capita (US\$): GDP in US dollar terms divided by midyear population.

Human development index (HDI): a composite index measuring average achievement in three basic dimensions of human development—a long and healthy life, knowledge and a decent standard of living.

Human poverty index (HPI): a composite index measuring deprivations in the three basic dimensions captured in the human development index—a long and healthy life, knowledge and a decent standard of living.

Internet users: people with access to the worldwide network.

Agricultural land: refers to the share of land area that is arable, under permanent crops, or 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 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 birth: the number of years a newborn infant would live if prevailing patterns of age-specific mortality rates at the time of birth were to stay the same throughout the child's life.

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

Population: refers to the de facto population in a country, area or region as of 1 July of the year indicated.

Population rural as a % of total: the urban–rural classification of population in internationally published statistics follows the national census definition, which differs from one country or area to another. National definitions are usually based on criteria that may include any of the following: size of population in a locality, population density, distance between built-up areas, predominant type of economic activity, legal or administrative boundaries and urban characteristics, such as specific services and facilities.

Population growth rates: estimates and projections of urban and rural populations are made by the Population Division of the United Nations Secretariat and published every two years. These estimates and projections are based on national census or survey data that have been evaluated and, whenever necessary, adjusted for deficiencies and inconsistencies

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

Water (access to): the share of the population with reasonable access to any of the following types of water supply for drinking: household connections, public standpipes, boreholes, protected dug wells, protected springs and rainwater collection. Reasonable access is defined as the availability of at least 20 litres a person per day from a source within one kilometre of the user's dwelling.

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

Papua New Guinea and Pacific island countries

PAPUA NEW GUINEA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|----------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Oil palm fruit | 1,400,000 | Game meat | 330,000 | Marine fish | 251,327 |
| Bananas | 870,000 | Pig meat | 68,000 | Misc aquatic animals | 28,967 |
| Coconuts | 677,000 | Chicken meat | 5,670 | Freshwater fish | 10,814 |
| Sweet potatoes | 520,000 | Hens eggs | 4,800 | Diadromous fish | 853 |
| Sugar cane | 450,000 | Cattle meat | 3,200 | Crustaceans | 578 |

FIJI

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|----------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Sugarcane | 3,200,000 | Cow milk, whole, fresh | 58,000 | Marine fish | 44,695 |
| Coconuts | 140,000 | Chicken meat | 11,700 | Molluscs | 1,726 |
| Taro (cocoyam) | 38,000 | Cattle meat | 8,400 | Crustaceans | 1,312 |
| Cassava | 34,500 | Pig meat | 4,050 | Misc aquatic animals | 729 |
| Rice, paddy | 15,000 | Hens eggs | 3,600 | Freshwater fish | 373 |

SOLOMON ISLANDS

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|----------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Coconuts | 276,000 | Pig meat | 2,300 | Marine fish | 31,232 |
| Oil palm fruit | 155,000 | Cow milk, whole, fresh | 1,400 | Misc aquatic animals | 20 |
| Sweet potatoes | 86,000 | Cattle meat | 750 | Crustaceans | 15 |
| Taro (cocoyam) | 40,000 | Hens eggs | 510 | Molluscs | 5 |
| Yams | 30,000 | Chicken meat | 300 | | |

VANUATU

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|------------------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Coconuts | 322,000 | Cow milk, whole, fresh | 3,200 | Marine fish | 85,036 |
| Roots and tubers | 43,000 | Pig meat | 2,850 | Crustaceans | 268 |
| Bananas | 14,500 | Cattle meat | 2,750 | Molluscs | 55 |
| Vegetables, fresh | 11,500 | Chicken meat | 550 | Misc aquatic animals | 15 |
| Ground nuts with shell | 2,550 | Hens eggs | 370 | Freshwater fish | 13 |

SAMOA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------------------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Coconuts | 146,000 | Pig meat | 4,000 | Marine fish | 3,980 |
| Bananas | 23,000 | Cow milk, whole, fresh | 1,500 | Misc aquatic animals | 222 |
| Taro (cocoyam) | 17,600 | Cattle meat | 1,000 | Crustaceans | 203 |
| Pineapples | 4,600 | Natural honey | 400 | Molluscs | 200 |
| Mangoes, mangosteen and guava | 4,000 | Chicken meat | 340 | Freshwater fish | 4 |

TONGA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-----------------------------|---------------------|------------------------------|---------------------|-------------|---------------------|
| Coconuts | 58,500 | Pig meat | 1,550 | Marine fish | 2,145 |
| Pumpkins, squash and gourds | 21,000 | Cow milk, whole, fresh | 370 | Crustaceans | 350 |
| Cassava | 9,700 | Cattle meat | 360 | Molluscs | 54 |
| Sweet potatoes | 6,800 | Chicken meat | 330 | | |
| Vegetables, fresh | 5,700 | Hens eggs | 30 | | |

South-East Asia

INDONESIA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|----------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Oil palm fruit | 78,000,000 | Chicken meat | 1,330,970 | Marine fish | 4,120,171 |
| Rice, paddy | 57,048,558 | Hens eggs | 1,095,320 | Freshwater fish | 1,030,597 |
| Sugarcane | 25,200,000 | Cow milk, whole, fresh | 636,860 | Crustaceans | 637,895 |
| Cassava | 19,610,071 | Pig meat | 59,7000 | Diadromous fish | 360,926 |
| Coconuts | 17,000,000 | Cattle meat | 418,210 | Molluscs | 166,890 |

VIETNAM

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Rice, paddy | 35,566,800 | Pig meat | 2,500,000 | Freshwater fish | 1,663,900 |
| Sugarcane | 16,000,000 | Chicken meat | 344,000 | Marine fish | 1,433,000 |
| Cassava | 8,900,000 | Cow milk, whole, fresh | 243,000 | Crustaceans | 668,100 |
| Vegetables, fresh | 6,600,000 | Hens eggs | 225,000 | Molluscs | 512,900 |
| Maize | 4,312,500 | Cattle meat | 166,000 | Misc aquatic animals | 17,190 |

PHILIPPINES

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Sugarcane | 25,300,000 | Pig meat | 1,501,000 | Marine fish | 2,187,619 |
| Rice, paddy | 16,000,000 | Chicken meat | 638,000 | Diadromous fish | 355,836 |
| Coconuts | 15,580,000 | Hens eggs | 530,000 | Freshwater fish | 355,279 |
| Bananas | 7,000,000 | Cattle meat | 170,000 | Molluscs | 172,063 |
| Maize | 6,730,000 | Buffalo meat | 75,500 | Crustaceans | 137,567 |

CAMBODIA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Rice, paddy | 5,995,000 | Pig meat | 140,000 | Freshwater fish | 452,970 |
| Cassava | 2,000,000 | Cattle meat | 63,000 | Marine fish | 37,000 |
| Vegetables, fresh | 487,000 | Cow milk, whole, fresh | 23,800 | Crustaceans | 19,330 |
| Maize | 380,000 | Chicken meat | 16,500 | Molluscs | 4,900 |
| Sugarcane | 170,000 | Hens eggs | 13,300 | | |

LAO PDR

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Rice, paddy | 2,870,000 | Pig meat | 47,000 | Freshwater fish | 104,925 |
| Vegetables, fresh | 660,000 | Cattle meat | 23,000 | | |
| Maize | 450,000 | Buffalo meat | 18,600 | | |
| Sugarcane | 220,000 | Chicken meat | 17,100 | | |
| Cassava | 175,000 | Hens eggs | 12,800 | | |

EAST TIMOR

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|------------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Maize | 63,430 | Pig meat | 10,080 | Marine fish | 344 |
| Cassava | 49,720 | Chicken meat | 1,840 | Crustaceans | 4 |
| Rice, paddy | 41,386 | Hens eggs | 1,600 | Misc aquatic animals | 1 |
| Roots and tubers | 34,370 | Cattle meat | 1,100 | Molluscs | 1 |
| Sweet potatoes | 26,000 | Buffalo meat | 570 | | |

THAILAND

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|----------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Sugarcane | 64,365,682 | Chicken meat | 1,050,000 | Marine fish | 1,943,105 |
| Rice, paddy | 27,879,000 | Pig meat | 700,000 | Freshwater fish | 693,761 |
| Cassava | 26,411,233 | Cow milk, whole, fresh | 683,898 | Crustaceans | 645,394 |
| Oil palm fruit | 7,642,598 | Hens eggs | 531,537 | Molluscs | 538,909 |
| Maize | 3,619,021 | Cattle meat | 197,991 | Misc aquatic animals | 21,642 |

BURMA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|------------------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Rice, paddy | 32,610,000 | Cow milk, whole, fresh | 900,000 | Marine fish | 1,485,740 |
| Sugarcane | 7,450,000 | Chicken meat | 653,000 | Freshwater fish | 1,273,937 |
| Vegetables, fresh | 3,200,000 | Pig meat | 380,000 | Crustaceans | 78,363 |
| Beans, dry | 1,765,000 | Hens eggs | 212,000 | Misc aquatic animals | 2,200 |
| Ground nuts with shell | 1,000,000 | Buffalo milk, whole, fresh | 205,000 | | |

South Asia and Middle East

INDIA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Sugarcane | 355,520,000 | Buffalo milk, whole, fresh | 56,960,000 | Freshwater fish | 3,948,901 |
| Rice, paddy | 141,134,000 | Cow milk, whole, fresh | 42,140,000 | Marine fish | 2,613,709 |
| Wheat | 74,890,000 | Goat milk, whole, fresh | 3,823,000 | Crustaceans | 596,934 |
| Potatoes | 26,280,000 | Hens eggs | 2,670,000 | Molluscs | 86,600 |
| Vegetables, fresh | 24,418,700 | Chicken meat | 2,200,000 | Diadromous fish | 43,139 |

PAKISTAN

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Sugarcane | 54,752,000 | Buffalo milk, whole, fresh | 21,500,000 | Marine fish | 311,557 |
| Wheat | 23,520,000 | Cow milk, whole, fresh | 11,000,000 | Freshwater fish | 230,000 |
| Rice, paddy | 8,300,000 | Goat milk, whole, fresh | 699,000 | Crustaceans | 22,439 |
| Seed cotton | 6,500,000 | Cattle meat | 562,000 | Molluscs | 6,071 |
| Maize | 3,240,000 | Buffalo meat | 551,000 | Diadromous fish | 215 |

BANGLADESH

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Rice, paddy | 43,504,000 | Goat milk, whole, fresh | 2,016,000 | Freshwater fish | 1,783,288 |
| Sugarcane | 6,000,000 | Cow milk, whole, fresh | 818,000 | Diadromous fish | 279,189 |
| Potatoes | 4,300,000 | Goat meat | 195,000 | Marine fish | 238,825 |
| Vegetables, fresh | 1,017,000 | Cattle meat | 184,000 | Crustaceans | 138,709 |
| Bananas | 838,000 | Hens eggs | 134,500 | | |

BHUTAN

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|--------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Maize | 94,500 | Cow milk, whole, fresh | 41,100 | Marine fish | 1,485,740 |
| Rice, paddy | 69,000 | Cattle meat | 5,100 | Freshwater fish | 1,273,937 |
| Potatoes | 57,000 | Pig meat | 930 | Crustaceans | 7,863 |
| Oranges | 36,500 | Buffalo milk, whole, fresh | 320 | Misc aquatic animals | 2,200 |
| Citrus fruit | 32,000 | Chicken meat | 250 | | |

AFGHANISTAN

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Wheat | 3,800,000 | Cow milk, whole, fresh | 2,035,000 | Freshwater fish | 1,000 |
| Vegetables, fresh | 540,000 | Cattle meat | 175,000 | | |
| Barley | 400,000 | Goat milk, whole, fresh | 97,500 | | |
| Rice, paddy | 369,840 | Goat meat | 43,000 | | |
| Grapes | 350,000 | Hens eggs | 18,300 | | |

IRAQ

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-----------------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Wheat | 1,700,000 | Cow milk, whole, fresh | 400,000 | Freshwater fish | 59,570 |
| Tomatoes | 830,000 | Chicken meat | 97,000 | Marine fish | 12,020 |
| Potatoes | 740,000 | Goat milk, whole, fresh | 52,000 | Diadromous fish | 1,611 |
| Barley | 500,000 | Hens eggs | 50,000 | Crustaceans | 388 |
| Cucumber and gherkins | 480,000 | Cattle meat | 50,000 | | |

North Asia

CHINA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------------|---------------------|------------------------------|---------------------|----------------------|---------------------|
| Rice, paddy | 187,040,000 | Pig meat | 61,150,000 | Freshwater fish | 18,678,462 |
| Maize | 151,970,000 | Cow milk, whole, fresh | 32,820,095 | Molluscs | 12,234,680 |
| Vegetables, fresh | 147,200,000 | Hens eggs | 25,846,300 | Marine fish | 9,075,497 |
| Wheat | 109,860,350 | Chicken meat | 10,856,800 | Crustaceans | 5,054,959 |
| Sugarcane | 106,316,000 | Cattle meat | 7,272,010 | Misc aquatic animals | 672,955 |

Southern and eastern Africa

SOUTH AFRICA, REPUBLIC OF

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-----------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Sugarcane | 20,500,000 | Cow milk, whole, fresh | 3,000,000 | Marine fish | 655,540 |
| Maize | 7,338,738 | Chicken meat | 975,000 | Molluscs | 11,856 |
| Potatoes | 1,900,000 | Cattle meat | 805,000 | Crustaceans | 3,684 |
| Wheat | 1,756,900 | Hens eggs | 385,000 | Freshwater fish | 1,280 |
| Grapes | 1,600,000 | Pig meat | 150,000 | Diadromous fish | 1,000 |

ETHIOPIA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|------------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Roots and tubers | 4,500,000 | Cow milk, whole fresh | 1,580,000 | Freshwater fish | 13,253 |
| Maize | 4,000,000 | Cattle meat | 350,000 | | |
| Wheat | 3,000,000 | Camel milk, whole, fresh | 175,000 | | |
| Sugarcane | 2,470,000 | Sheep meat | 79,000 | | |
| Sorghum | 2,300,000 | Game meat | 77,000 | | |

KENYA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|----------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Sugarcane | 4,950,000 | Cow milk, fresh, whole | 3,500,000 | Freshwater fish | 1284,57 |
| Maize | 3,240,000 | Cattle meat | 390,000 | Marine fish | 6,399 |
| Cassava | 850,000 | Goat milk, fresh, whole | 108,000 | Crustaceans | 638 |
| Sweet potatoes | 800,000 | Hens eggs | 53,000 | Molluscs | 413 |
| Potatoes | 800,000 | Goat meat | 38,500 | Diadromous fish | 81 |

TANZANIA

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|----------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Cassava | 6,600,000 | Cow milk, whole, fresh | 850,000 | Freshwater fish | 284,350 |
| Maize | 3,400,000 | Cattle meat | 247,000 | Marine fish | 41,933 |
| Sugarcane | 2,750,000 | Goat milk, whole, fresh | 105,000 | Crustaceans | 1,656 |
| Rice, paddy | 1,240,000 | Chicken meat | 45,700 | Molluscs | 882 |
| Sweet potatoes | 960,000 | Hens eggs | 35,100 | Diadromous fish | 6 |

MALAWI

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|----------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Cassava | 2,600,000 | Cow milk, whole, fresh | 35,000 | Freshwater fish | 57,000 |
| Maize | 2,100,000 | Pig meat | 20,986 | | |
| Sugarcane | 1,800,000 | Hens eggs | 19,500 | | |
| Rice, paddy | 1,750,000 | Cattle meat | 15,985 | | |
| Sweet potatoes | 360,000 | Chicken meat | 14,770 | | |

MOZAMBIQUE

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-----------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Cassava | 7,350,000 | Cow milk, whole, fresh | 60,500 | Marine fish | 55,788 |
| Sugarcane | 2,650,000 | Chicken meat | 39,500 | Freshwater fish | 24,226 |
| Maize | 1,579,400 | Cattle meat | 38,100 | Crustaceans | 12,405 |
| Sorghum | 350,000 | Hens eggs | 14,000 | Molluscs | 689 |
| Coconuts | 265,000 | Pig meat | 13,000 | | |

ZIMBABWE

| Crops | Production (tonnes) | Livestock/Livestock products | Production (tonnes) | Fisheries | Production (tonnes) |
|-------------------|---------------------|------------------------------|---------------------|-----------------|---------------------|
| Sugarcane | 3,600,000 | Cow milk, whole, fresh | 250,000 | Freshwater fish | 12,950 |
| Maize | 952,600 | Cattle meat | 97,000 | | |
| Seed cotton | 235,000 | Chicken meat | 40,000 | | |
| Cassava | 192,000 | Game meat | 32,000 | | |
| Vegetables, fresh | 135,000 | Pig meat | 27,500 | | |

Sources: Crop and Livestock Production, <<http://faostat.org>>, accessed 23 March 2009

Fisheries data, http://www.fao.org/fishery/statistics/global_production/query/en, accessed 25 March 2009

Appendix 5: Major forestry indicators for partner countries

| Region/country | Total forest area in 2005 (1,000 ha) | Percentage of land area in 2005 | Forest plantations in 2005 (1,000 ha) | Annual rate of change 2000–05 (%) |
|--|--------------------------------------|---------------------------------|---------------------------------------|-----------------------------------|
| Papua New Guinea and Pacific island countries | | | | |
| Papua New Guinea | 29,437 | 65.0 | 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 | 5.0 | Not specified | 0 |
| Kiribati | 2 | 30.0 | Not available | 0 |
| South-East Asia | | | | |
| Indonesia | 104,986 | 58.0 | 3,399 | -2.0 |
| Vietnam | 12,931 | 39.7 | 2,695 | 2.0 |
| Philippines | 7,162 | 24.0 | 620 | -2.1 |
| Cambodia | 10,447 | 59.2 | 59 | -2.0 |
| Lao PDR | 16,142 | 69.9 | 224 | -0.5 |
| East Timor | 798 | 53.7 | 43 | -1.3 |
| Thailand | 14,520 | 28.4 | 3,099 | -0.4 |
| Burma | 32,222 | 49.0 | 849 | -1.4 |
| South Asia | | | | |
| India | 67,701 | 22.8 | 3,226 | Not specified |
| Pakistan | 2,361 | 3.0 | 318 | -2.1 |
| Bangladesh | 871 | 6.7 | 279 | -0.3 |
| Bhutan | 3,195 | 68.0 | 2 | 0.3 |
| Afghanistan | 867 | 1.3 | Not available | -3.1 |
| North Asia | | | | |
| China | 197,290 | 21.2 | 31,369 | 2.2 |
| Southern Africa | | | | |
| South Africa | 9,203 | 7.6 | 1,426 | 0 |

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

Appendix 6: Acronyms and abbreviations

| | | | |
|-------------------------|--|-------------------------|---|
| ACACA | Australia–China Agricultural Cooperation Agreement | FMD | Foot-and-mouth disease |
| ACIAR | Australian Centre for International Agricultural Research | FST^a | Forestry |
| ADP^a | Agricultural Development Policy | FTE | Full-time equivalent (staff) |
| AGB^a | Agribusiness | GHG | Greenhouse gas |
| AH^a | Animal Health | GNI | Gross national income |
| AISRF | Australia–India Strategic Research Fund | HORT^a | Horticulture |
| AOP | Annual Operational Plan | HPAI | Highly pathogenic avian influenza |
| APAARI | Asia–Pacific Association of Agricultural Research Institutes | IARCs | International Agricultural Research Centres |
| APAFRI | Asia–Pacific Association of Forestry Research Institutes | ICARDA | International Centre for Agricultural Research in the Dry Areas (Syria) |
| APSIM | Agricultural Production Systems sIMulation (model) | ICRAF | World Agroforestry Centre (Kenya) |
| ARDSF | Agricultural Research and Development Support Facility | ICRISAT | International Crop Research Institute for the Semi-arid Tropics (India) |
| ASEM^a | Agricultural Systems Management | IDM | Integrated disease management |
| ASLP | Agriculture Sector Linkages Program | IFAD | International Fund for Agricultural Development |
| ATSE | Academy of Technological Sciences and Engineering (Australia) | IFPRI | International Food Policy Research Institute (USA) |
| AusAID | Australian Agency for International Development | IITA | International Institute of Tropical Agriculture |
| AVRDC | Asian Vegetable Research and Development Institute (Taiwan) | ILRI | International Livestock Research Institute (Kenya) |
| AYAD | Australian Youth Ambassadors for Development | IPGRI | International Plant Genetic Resources Institute (Italy) |
| CABI | Centre for Agriculture and Biosciences International (UK) | IPM | Integrated pest management |
| CARD | Capacity building for Agriculture and Rural Development (Vietnam) | IRRI | International Rice Research Institute (Philippines) |
| CARDI | Cambodian Agricultural Research and Development Institute | IUU | Illegal, unreported and unregulated |
| CARF | Cambodian Agricultural Research Fund | IWMI | International Water Management Institute (Sri Lanka) |
| CBO | Community-based organisation | LPS^a | Livestock Production Systems |
| CGIAR | Consultative Group on International Agricultural Research | LWR^a | Land and Water Resources |
| CIAT | International Centre for Tropical Agriculture (Colombia) | MAF | Ministry of Agriculture and Fisheries (East Timor) |
| CIFOR | Centre for International Forestry Research (Indonesia) | NARS | National Agricultural Research Systems |
| CIM^a | Crop Improvement and Management | NGO | Non-government organisation |
| CIMMYT | International Maize and Wheat Improvement Centre (Mexico) | NPP | New policy proposal |
| CIP | International Potato Centre (Peru) | NSW | New South Wales |
| CSF | Classical swine fever | ODA | Official development assistance |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation (Australia) | PHAMA | Pacific Horticultural and Agricultural Market Access Program |
| DAFF | Department of Agriculture, Fisheries and Forestry (Australia) | PIC | Pacific island country(ies) |
| DIISR | Department of Innovation, Industry, Science and Research (Australia) | PLIA | Policy Linkages and Impact Assessment |
| DPRK | Democratic People's Republic of Korea | PNG | Papua New Guinea |
| FAO | Food and Agriculture Organization | PSLP | Public Sector Linkages Program |
| FIS^a | Fisheries | R&D | Research and development |
| | | RPM | Research Program Manager |
| | | RSA | Republic of South Africa |
| | | SADI | Smallholder Agribusiness Development Initiative |
| | | SMCN^a | Soil Management and Crop Nutrition |
| | | SME | Small–medium enterprise |
| | | SPC | Secretariat of the Pacific Community |
| | | USP | University of the South Pacific |
| | | WTO | World Trade Organization |

^a ACIAR program