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Australian Centre for International Agricultural Research

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SOUTH ASIA

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ACIAR

Research that works for developing countries and Australia

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1 Overview

1.1 About ACIAR

The Australian Centre for International Agricultural Research (ACIAR) is an Australian government statutory authority that operates as part of the Australian Aid Program within the portfolio of Foreign Affairs and Trade. The core principles of Australia's aid program are:

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

These principles guide the aid program in delivering sustainable development gains.

ACIAR was established in 1982 to assist and encourage Australia's agricultural scientists to use their skills for the benefit of developing countries but also to work to resolve Australia's own agricultural problems. It contributes to the aid program objectives of advancing Australia's national interest, poverty alleviation and sustainability. Australia has an exceptionally strong capacity in agricultural research and development, and is also unique amongst developed countries in possessing large agricultural areas in the tropics and subtropics.

ACIAR's corporate mission is to achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia, through international agricultural research partnerships. ACIAR's principal goals are to reduce poverty, improve food security and care for the natural resource base for agriculture. To achieve these goals, ACIAR facilitates and supports bilateral research and development activities in a broad range of agricultural areas, including crop production and protection, animal health and animal production, fisheries, forestry, land and water resources management and postharvest technology. ACIAR also commissions studies of the economic and policy issues concerned with the management of agricultural systems and natural resources, and helps partner countries build their capacity to engage with the increasingly global market economy.

Research is not carried out by ACIAR itself. ACIAR plans, funds and manages projects which are carried out by public sector groups including universities, state departments, and other research providers such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), in partnership with their counterparts in developing countries.

ACIAR also administers the Australian Government's contribution to the international agricultural research centres, and links the centres through multilateral projects to Australian research organisations.

ACIAR is structured into the following research program areas:

- Agribusiness (AGB)
- Agricultural Development Policy (ADP)
- Agricultural Systems Management (ASEM)
- Animal Health (AH)
- Crop Improvement and Management (CIM)
- Cropping Systems and Economics (CSE)
- Fisheries (FIS)
- Forestry (FST)
- Horticulture (HORT)
- Land and Water Resources (LWR)
- Livestock Production Systems (LPS)
- Pacific Crops (PC)
- Soil Management and Crop Nutrition (SMCN).

In developing research projects for these regions, ACIAR places emphasis on priorities determined in consultation with partner countries, balancing these against Australia's comparative advantage and capacity to assist.

Our partnership model

ACIAR develops a specific program for each partner country that is aligned with its national agricultural priorities. The programs are developed in close consultation with government and research organisations from the partner country and Australia.

ACIAR's research also closely aligns with the Australian aid program's renewed focus on poverty reduction. It is integrated closely with the Australian 'whole-of-government' aid program strategies for specific regions.

Australia's scientists work within a very strong network of institutions in Australia and partner countries, including CSIRO, federal and state government organisations and universities.

ACIAR's projects are split up into bilateral and multilateral projects. Bilateral projects are led by an Australian organisation, with collaborators in the partner country and Australia. Multilateral projects are led by an international agricultural research centre (IARC), in partnership with other research organisations.

Where we work

ACIAR carries out research in the Asia–Pacific region, and currently has projects in the following regions:

- South-East Asia (Cambodia, East Timor, Indonesia, Laos, Philippines, Thailand, Vietnam: >45% bilateral expenditure)
- Papua New Guinea and the Pacific islands (>20% of bilateral expenditure)

- North Asia (China: <15% of bilateral expenditure)
- South Asia (Afghanistan, Bangladesh, Bhutan, India, Iraq, Pakistan: <15% of bilateral expenditure).

Working internationally

ACIAR is also responsible for Australia's relationship with the international agricultural research centres—the Consultative Group on International Agricultural Research (CGIAR) centres. ACIAR's annual outlay to the CGIAR centres is around $11 million.

These funds are used to facilitate CGIAR engagement in the Asia–Pacific and to commission projects that are consistent with ACIAR's country program strategies.

1.2 Capacity building and training

Building the capacity of agricultural research institutions and researchers in partner countries is one of ACIAR's key priorities. The training program aims to enhance the research capabilities of institutions and individuals involved in ACIAR projects. This also assists in research adoption, productive partnerships and project development.

The ACIAR training program has a budget in 2009–10 of approximately $6.58 million. It comprises five elements:

- fellowships for postgraduate students (John Allwright Fellowships)
- postgraduate returnee follow-up awards (Returnee Small Project Awards Scheme)
- leadership development opportunities for developing country scientists (John Dillon Memorial Fellowships)
- non-award training (short courses and workshops)
- support for the Crawford Fund, both through management of the Australian Government's contribution ($0.75 million) and sponsorship of attendees at Masterclasses and other selected training activities.

Much of ACIAR's training is carried out systematically within individual projects. In addition, specialised, discipline-specific training activities may also occur within ACIAR's individual research and development programs.

The ACIAR John Allwright Fellowship scheme accounts for approximately $5.6 million (this figure includes $3.5 million from the Australian Agency for International Development; AusAID) of the training program budget in 2009–10.

John Allwright Fellowships

The objective of the John Allwright Fellowships is to increase the research and development capacity of ACIAR partner-country institutions. The fellowships are awarded to partner-country researchers involved in an ACIAR project to undertake postgraduate studies in tertiary institutions in Australia. Studies focus on areas related to the topic or theme of the ACIAR project.

John Allwright Fellowships in India

		PhD	MSc/Other
Active	Male	5	0
	Female	2	0
Concluded	Male	3	1
	Female	3	0

John Allwright Fellowships in Pakistan

		PhD	MSc/Other
Active	Male	2	0
	Female	0	1
Concluded	Male	3	1
	Female	0	0

John Allwright Fellowships in Afghanistan

		PhD	MSc/Other
Active	Male	0	0
	Female	0	0
Concluded	Male	0	0
	Female	0	0

John Allwright Fellowships in Bhutan

		PhD	MSc/Other
Active	Male	0	1
	Female	0	0
Concluded	Male	0	0
	Female	0	0

John Allwright Fellowships in Iraq

		PhD	MSc/Other
Active	Male	0	0
	Female	0	0
Concluded	Male	0	0
	Female	0	0

Returnee Small Project Awards Scheme

The Returnee Small Project Awards Scheme provides small grants to John Allwright Fellows after they complete postgraduate studies and return to their employers in their home country. The scheme allows Fellows to undertake an activity that continues, or is related to, the ACIAR project in which they are involved. The funding is primarily for developing small-scale research projects, with the intention of catalysing longer-term support and ongoing international collaboration.

John Dillon Memorial Fellowships

John Dillon Fellowships provide career development opportunities in Australia for outstanding mid-career agricultural scientists and economists from ACIAR partner countries. The aim is to develop the leadership skills of Fellows in the area of agricultural research management, agricultural policy and/or extension technologies through exposure to Australian agriculture across a range of best-practice organisations involved in research, extension and policymaking.

Short courses and workshops

A limited number of short courses and workshops are undertaken as part of the training program for people involved in ACIAR projects. Most activities are directly managed by ACIAR, but some are managed by the Crawford Fund. The courses and workshops are presented by both public- and private-sector providers and topics are chosen based on advice from senior officials in partner countries.

On-the-job training

On-the-job training as part of ACIAR projects has been shown to deliver excellent returns in terms of capacity building (in addition to the benefits to farmers). The partnership model for ACIAR projects means that Australian and partner-country scientists are working side by side throughout the life of the project.

India

2 India chapter from the Annual Operational Plan 2009–10

2.1 Medium-term strategy

The emphasis of the India–Australia collaborative research partnerships in the main wheat-growing areas has shifted from maintaining the sustainability of wheat-based cropping systems to improving productivity, through development of new varieties resistant to major biotic and abiotic stresses. This is being achieved through the application of marker-assisted selection as a tool to achieve greater efficiencies in wheat breeding. This theme is being delivered through a joint program implemented in 2008 and co-funded by the Indian Council for Agricultural Research and ACIAR. In the less-favoured areas of India's rainfed central plateau, a second subprogram addresses broad-scale land and water resource management. This is augmenting the earlier technical focus with complementary research on cropping systems, and institutional and policy issues related to water management. This subprogram applies technical, economic and policy research approaches to increase water productivity, and will have an increasing focus on climate issues, in particular adaptation to climate change. Project design which will emphasise strengthened integration will include greater involvement of farmers and non-government organisations (NGOs), and engagement with policymakers, with a view to achieving quicker impact.

Policy analysis research at the national and state levels will complement both themes, with a shift from stand-alone policy projects to integration of policy components into projects of the main two themes. This will include research into domestic agricultural policy and trade-related reform options, and will consider in future cycles, plausible scenarios and futures for agriculture and food security.

2.2 Key performance indicators (2009–10)

- linkages to international bioinformatics initiatives implemented as part of the joint Indo–Australian collaborative program on marker-assisted breeding in wheat
- introgression of genes conferring 'stay-green' characteristics into elite sorghum germplasm
- use of improved technologies for crop establishment and production in the rice–wheat and rice-based farming systems of north-western and eastern India
- activities addressing climate change management and climate adaptation integrated into the water productivity program in Andhra Pradesh
- enhanced understanding of policy and institutional arrangements, community-based water harvesting and impacts of watershed development on equity of water use in central India
- identified competition policy options to facilitate regulatory and market reform in the agricultural sector addressed through communication of analytical studies.

2.3 Position

India faces very significant problems in its rural sector, even as the overall economy forges ahead. Indeed, the greatest number of poor and undernourished people in any country (approximately 300 million) is found in India, and most live in rural areas. At the same time, India faces trade liberalisation and rapid diversification of diets towards high-value agricultural products.

ACIAR's collaborative program in India has evolved into a tightly focused suite of projects in three subprograms. These take into account national agricultural priorities and the key themes through which agricultural research in the two countries can achieve synergies. The Government of India is also encouraging donors to work with independent research organisations and NGOs. Partnerships with NGOs will help increase emphasis on achieving practical farmer-level impacts, particularly in poorer regions. Involvement of independent policy institutions and their linkage to central and state government departments will also increase the likelihood of policy impacts.

India has a large and well-developed national agricultural research system. The Indian Council for Agricultural Research has several major programs, including the World Bank–funded National Agriculture Innovation Programme and the United States–India Agriculture Knowledge Initiative, both of which share similar research priorities with the ACIAR program. ACIAR will maximise collaboration in areas of Australian expertise as well as in areas where both India and Australia have strong common interests and potential for field-level and trade impacts in both countries. ACIAR will engage mainly with researchers in the main wheat-growing states (Punjab, Haryana, Madhya Pradesh and Uttar Pradesh) and the Indian central plateau (Andhra Pradesh, with outreach to Karnataka, Maharashtra and West Bengal). Projects will help India manage scarce water and nutrient resources more efficiently, improve yield and quality of cereals and oilseeds, diversify production and raise farm incomes. Rainfed cropping systems in central and eastern India are prone to the effects of seasonal climate variability and, in the long term, impacts of climate change. India is one of four partner countries involved in ACIAR's climate change adaptation initiative designed for implementation during 2009–10.

A number of international agricultural research centres (IARCs) are also active in India. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), with headquarters in Hyderabad, has strong programs on peanut, sorghum, millet and chickpea, as well as crop–livestock systems (with the International Livestock Research Institute; ILRI) and soil management in the semi-arid tropics. The International Maize and Wheat Improvement Center (CIMMYT) and the International Rice Research Institute (IRRI) have significant regional activities in India, many connected with the rice–wheat eco-regional initiative. The International Water Management Institute (IWMI) has a joint program on policy issues, with an Indian research institute and other biophysical programs in India. ACIAR supports projects with these IARCs.

2.4 Relationship of ACIAR activities to AusAID and other Australian Government programs in India

Australia's Development Cooperation Framework with South Asia for 2003–07 'sought to maximise the effectiveness of programs reducing vulnerability and increasing the productivity of the poor', with an emphasis on the areas of 'health and sanitation, education and natural resources management'. It recognised that countries 'are at different stages of development, each with their own development priorities', and the strategy should respond to humanitarian and emergency assistance needs as they arise'. A new framework for 2008–13 is currently under development.

A new 5-year $10 million Australia–India Public Sector Linkages Program (PSLP) was announced by AusAID in June 2008. The PSLP offers Australian federal, state and territory government agencies, as well as universities, competitive funding to develop linkages with public counterpart institutions in India.

The Australian Government Department of Innovation, Industry, Science and Research (DIISR) administers the Australia–India Strategic Research Fund (AISRF), which commenced in 2006–07 and will provide $20 million over 5 years. This program supports collaborative research activities between Australia and India, with the Government of India committed to providing matching funds. Competitive funding

under the AISRF is available through the $6 million Indo-Australian Science and Technology Fund (administered jointly with the Indian Department of Science and Technology) and the $6 million Indo-Australian Biotechnology Fund (administered jointly with the Indian Department of Biotechnology). Priority areas under these two funds include agricultural research (transgenic crops), environment sciences (nutraceuticals and functional foods) and marine sciences (bioremediation). Coordination between DIISR and ACIAR ensures that agricultural research projects supported under the AISRF complement the ACIAR India program. Application details can be accessed at: <https://grants.innovation.gov.au/AISRF/>.

The Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) has a growing interest in India. It has developed a strategy with a strong trade focus, reflecting the increasing importance of India in the World Trade Organization (WTO) and as a market for Australian agricultural commodities. ACIAR will collaborate to identify and undertake timely policy research and analysis designed to address opportunities for both agricultural trade and domestic policy reform in India.

2.5 Research priorities

ACIAR has a program of consultation with India to establish priorities in research collaboration. The most recent review of priorities, held between July 2006 and May 2007, led to the emergence of several focal areas. These are outlined below.

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

- Application of rust and alternative genes to provide varieties with improved leaf, stripe and stem rust resistances
- Identification and application of suitable traits and markers for coping with abiotic stresses
- Identification and application of wheat quality traits.

Subprogram 2: Water management and productivity for enhanced livelihoods in rainfed areas of the central plateau, with emphasis on Andhra Pradesh

- Implementation of sustainable water harvesting and watershed development
- Informing of water resource management and policymaking to optimise water productivity
- Improvement in water productivity of rainfed cropping and livestock systems
- Adaptation of farming systems to cope with climate change.

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

- Adjustment to the challenges and opportunities of international trade
- Facilitation of private-sector investment in agribusiness and marketing
- Safeguarding of smallholder livelihoods in the transition from a regulated to a market economy.

3 Active projects in India

3.1 Subprogram 1: Application of marker-assisted selection as a tool in wheat breeding

Wheat is the major crop of both India and Australia and is grown in similar environmental conditions in both countries. Although farm size is very different in the two countries, there are many similar production constraints. The north-west is India's major grain-growing area, and continued productivity is central to farmer livelihood and food-security considerations. Until recently, the ACIAR focus in this program has been to underpin the broader sustainability of wheat-based cropping. This has comprised a cluster of projects addressing a range of soil and water management and productivity issues involving improved nutrient management and zero tillage. It has been complemented by a set of projects revolving around the development of improved wheat varieties that can cope with biophysical soil constraints such as waterlogging and soil sodicity/salinity.

Following a joint review of priorities in 2006–07, it was agreed to strengthen the focus on the application of marker-assisted selection as a tool to achieve greater efficiencies in wheat breeding. This new subprogram shares costs and benefits between the partner countries. It recognises advanced research capabilities in both countries, as well as the central and catalytic role of the active project 'Molecular marker technologies for faster wheat breeding' in the process.

Project number	*Project title*
CIM/2003/067 (multilateral)	Ensuring productivity and food security through sustainable control of yellow rust of wheat in Asia (CIMMYT)
CIM/2005/020	Molecular marker technologies for faster wheat breeding in India
CIM/2006/071	Indo-Australian project on root and establishment traits for greater water-use efficiency in wheat
CIM/2006/094	Enhancing farm profitability in north-western India and South Australia by improving grain quality of wheat
CIM/2006/177	Wheat improvement for waterlogging, salinity and element toxicities in Australia and India
CIM/2007/064	Linking India and Australia to a global strategy for the Ug99 stem rust pathotype
CIM/2007/084	Molecular markers for broadening the genetic base of stem rust resistance genes effective against strain Ug99
CSE/2004/033	Zero-tillage rice establishment and crop–weed dynamics in rice and wheat cropping systems in India and Australia
CSE/2006/124	Fine-tuning the Happy Seeder technology for adoption in north-western India
LWR/2002/032	Integrated manure nutrient management in soybean–wheat cropping systems on vertisols in Madhya Pradesh and Queensland

CIM/2003/067: Ensuring productivity and food security through sustainable control of yellow rust of wheat in Asia

Losses of wheat crops from cereal rust diseases are a major threat to food security. Yellow rust (*Puccinia striiformis* f. sp. *tritici* or Pst) affects wheat in most conditions and is therefore a major threat throughout Asia. Yellow rust's causal agent (Pst) is capable of rapid evolution into new wheat races and of migrating long distances on the wind. Host-plant resistance is the main control, but breakdowns of resistance in China, Pakistan and elsewhere in central and western Asia have recently occurred. Resistant gene isolines will be used to monitor Pst virulence in Asia as an early warning system against further outbreaks. These isolines will also be used to help identify resistance genes for introduction into new cultivars.

Overseas collaborating countries

Afghanistan, Bangladesh, China, India, Pakistan

Commissioned organisation

International Maize and Wheat Improvement Center, Mexico

Project leader

Dr Ravi Singh
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Collaborating institutions

International Center for Agricultural Research in the Dry Areas, Syria
University of Sydney, Australia

Project budget

$1,000,050

Project duration

01/01/2005 to 31/12/2009

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2003/067>

CIM/2005/020: Molecular marker technologies for faster wheat breeding in India

In India, there is an urgent need for efficient new wheat cultivars with increased yield. Improved rust resistance will help to lift production, and this project is focusing on developing this resistance through the application of molecular technology. Already India possesses many of the research skills and infrastructure required for this project, including high-throughput molecular tools. However, the country needs better information-management systems and marker adoption strategies integrated into its applied wheat-breeding programs. Australia is offering expertise and experience to facilitate the cohesive linkage of the components to breeding, while targeting an array of stem, leaf and stripe rust gene combinations.

Overseas collaborating country

India

Commissioned organisation

University of Sydney, Plant Breeding Institute, Australia

Project leader

Professor Richard Trethowan
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Email: r.trethowan@camden.usyd.edu.au

Collaborating institutions

Directorate of Wheat Research, India
Punjab Agricultural University, India

Project budget

$1,283,060

Project duration

01/05/2007 to 30/04/2012

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2005/020>

CIM/2006/071: Indo-Australian project on root and establishment traits for greater water use efficiency in wheat

This project is the first to be developed using the new Indo-Australia Program on Marker Assisted Wheat Breeding (IAP-MAWB) modality. Its purpose is to develop wheat varieties with deeper, faster-growing roots that better exploit soil moisture and increase yields in rainfed or minimally irrigated systems in India and Australia. The activities span nine wheat-growing seasons. At three Australian and five Indian core sites, the joint research team will study root growth rates, rooting depth and potential for genetic improvement. The team will also co-develop protocols to measure root growth in controlled environments and leaf temperature in the field. In addition, the team will investigate shoot characteristics that influence crop establishment and water-use efficiency. Desired outcomes are development of wheat-breeding populations that combine desirable traits for increasing yields in water-limited conditions in Australia and India, and also identification of molecular markers that indicate traits for deeper roots and better crop establishment.

Overseas collaborating country

India

Commissioned organisation

CSIRO Plant Industry, Australia

Project leader

Dr Michelle Watt
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Collaborating institutions

Agharkar Research Institute, India
Department of Employment, Economic Development and Innovation, Australia
Directorate of Wheat Research, India
Indian Agricultural Research Institute, India
Indian Council of Agricultural Research, India
Narendra Deva University of Agricultural Technology, India

Project budget

$1,000,000

Project duration

01/06/2009 to 31/05/2013

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2006/071>

CIM/2006/094: Enhancing farm profitability in north-western India and South Australia by improving grain quality of wheat

Wheat yields in Haryana in north-western India seem to be either stagnant or declining despite the introduction of high-yielding varieties (genetics), improved cultural practices (agronomy), and rapid adoption of zero tillage by about 15% of farmers. This project aims to increase the profitability of wheat farming in Haryana by integrating agronomy-management improvements with market-based quality outcomes. The primary objective is to develop innovative nitrogen-management scheduling with sustainable production practices that optimise specific grain-quality attributes, both for India and Australia. Through developing an environmental management system approach to crop monitoring, the scientists will also demonstrate the need to better manage nitrogen nutrition and increase nitrogen-use efficiency across the range of crop rotations.

Overseas collaborating country

India

Commissioned organisation

University of Adelaide, Department of Agronomy and Farming Systems, Australia

Project leader

Professor David Coventry
Phone: 08 8303 7954
Fax: 08 8303 7730
Email: david.coventry@adelaide.edu.au

Collaborating institutions

Chaudhary Charan Singh (CCS) Haryana Agricultural University, India
Department of Primary Industries and Resources, South Australia, Australia
Directorate of Wheat Research, India

Project budget

$398,475

Project duration

01/07/2007 to 30/06/2010

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2006/094>

CIM/2006/177: Wheat improvement for waterlogging, salinity and element toxicities in Australia and India

A major finding of past ACIAR-supported research is that waterlogging tolerance is a product of tolerance to anaerobiosis from waterlogging and to certain elements at toxic levels (aluminium, boron, iron, manganese and sodium) that vary with target environments and are exacerbated during waterlogging. The aim of this project is to apply the outcomes of this research to underpin breeding of waterlogging-tolerant wheat varieties. Project objectives are to: 1. confirm key mechanisms of waterlogging tolerance by physiological and soils data identifying microelement/element toxicities; 2. establish screening facilities and protocols to characterise waterlogging tolerance; 3. implement optimal cereal-breeding strategies for the production of elite germplasm with waterlogging tolerance; and 4. breed elite germplasm with waterlogging and element tolerance. The identification of robust screening protocols and the development of elite germplasm with waterlogging tolerance are outcomes that should bring significant economic benefits with the release of varieties incorporating identified tolerances—in the range of $200 million per annum in both India and Australia.

Overseas collaborating country

India

Commissioned organisation

Department of Agriculture and Food, Western Australia, Australia

Project leader

Dr Tim Setter
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Collaborating institutions

Central Soil Salinity Research Institute, India
Directorate of Wheat Research, India
Indian Council of Agricultural Research, India
Narendra Deva University of Agricultural Technology, India
Narendra Deva (ND) University of Agriculture and Technology, India
University of Adelaide, Australia

Project budget

$899,996

Project duration

01/07/2008 to 31/12/2012

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2006/177>

CIM/2007/064: Linking India and Australia to a global strategy for the Ug99 stem rust pathotype

Stem rust is a fungal disease of wheat, and in 1999 a new stem rust pathotype, Ug99 or TTKS, was identified in Uganda. It is virulent on many commercial cultivars of wheat and is capable of overcoming a number of important stem rust resistance genes. This pathotype has spread to other East African nations and to Yemen, and there is a high likelihood that it will reach and threaten the wheat-growing regions of Asia. This small research activity augments the global program to combat Ug99. Specific aims are to: develop genetic stocks for future marker development for new sources of adult plant stem rust resistance; develop DNA (deoxyribonucleic acid) markers for pyramiding seedling resistance genes effective against Ug99; facilitate the deployment of the newly developed markers in breeding programs; and develop a large ACIAR project (CIM/2007/084) that will extend and intensify these activities for a further 4 years.

Overseas collaborating country

India

Commissioned organisation

CSIRO Plant Industry, Australia

Project leader

Dr Evans Lagudah
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Collaborating institutions

Directorate of Wheat Research, India
Indian Agricultural Research Institute, India
University of Agricultural Sciences, India
University of Sydney, Australia

Project budget

$150,000

Project duration

01/04/2008 to 30/06/2009
(Project extended from 01/04/2009 to 30/06/2009)

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2007/064>

CIM/2007/084: Molecular markers for broadening the genetic base of stem rust resistance genes effective against strain Ug99

Ug99 is a strain of stem rust first identified in Uganda in 1998 and confirmed in 1999. It attacks many commercial cultivars of wheat by overcoming important resistance genes, and there is evidence of its continued rapid evolution. Thus 50 million hectares—potentially 25% of the world's wheat—is at risk, with more than 90% of cultivars deemed susceptible along the predicted spore migration route. This project will involve Indian researchers and partners from the Australian Cereal Rust Control Program (ACRCP). Australia will gain from the experience in India, which is closer to the frontline of Ug99 impact based on movement of spores by wind and weather. Major aims of the project are to: 1. identify potentially new genetic diversity for adult plant stem rust resistance to be deployed against Ug99 and derivative races; 2. develop and validate simple and robust molecular markers linked to genes effective against Ug99 and derivative races and assist with the implementation of markers in breeding programs to produce resistant cultivars; 3. compare stem rust pathogen variability between Australian and Indian isolates and contribute to the knowledge base that will assist with pre-emptive breeding strategies; 4. liaise with Cornell University Durable Rust Resistance in Wheat project (under the auspices of the Borlaug Global Rust Initiative) to build capacity for global strategies that will achieve durable resistance to rust in wheat.

Overseas collaborating country

India

Commissioned organisation

CSIRO Plant Industry, Australia

Project leader

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Collaborating institutions

Directorate of Wheat Research, India
Indian Agricultural Research Institute, India
Indian Council of Agricultural Research, India
University of Sydney, Australia

Project budget

$1,000,000

Project duration

01/06/2009 to 31/05/2013

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2007/084>

CSE/2004/033: Zero-tillage rice establishment and crop–weed dynamics in rice and wheat cropping systems in India and Australia

In India, rice–wheat systems are planted extensively. One problem commonly encountered is degradation of soil structures, caused by excessive tillage and puddling of water for rice production. No-till systems for wheat, developed and introduced in past ACIAR research, have opened the way for no-till rice cropping. Preliminary research suggests no-till rice can also be grown, substantially boosting the benefits of no-till wheat that are often subsumed by tillage and puddling in rice cultivation. Improving the productivity of direct-seeded rice, including by weed and crop management improvements, will be undertaken to minimise the yield gap between wheat and rice.

Overseas collaborating country

India

Commissioned organisation

University of Adelaide, School of Agriculture and Wine, Australia

Project leader

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Collaborating institutions

CCS Haryana Agricultural University, India
International Maize and Wheat Improvement Center, India
Punjab Agricultural University, India

Project budget

$1,000,710

Project duration

01/07/2006 to 30/06/2011

ACIAR Research Program Manager

Dr John Dixon

Website

<www.aciar.gov.au/project/CSE/2004/033>

CSE/2006/124: Fine-tuning the Happy Seeder technology for adoption in north-western India

Burning is the normal method of rice-stubble management in mechanically harvested rice–wheat-growing areas of north-western India. This causes air pollution and loss of soil health as well as impacting on human and animal health. In a prior ACIAR project, a new generation of seeders capable of direct drilling wheat into heavy rice residue loads without prior burning was developed ('Happy Seeder' technology). This project intends to reduce the environmental and community impacts of residue burning by enabling an accelerated roll-out of the Happy Seeder technology developed earlier. Charles Sturt University, NSW Department of Primary Industries, the International Rice Research Institute and the Punjab Agricultural University will work with farmer groups, contractors and a machinery manufacturer to optimise the technology across different sites in Punjab. The project will generate significant potential economic and social benefits in higher returns to farmers and improved health and air quality.

Overseas collaborating country

India

Commissioned organisation

Charles Sturt University, International Centre of Water for Food Security, Australia

Project leader

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Collaborating institutions

International Rice Research Institute, India
NSW Department of Primary Industries, Australia
Punjab Agricultural University, India

Project budget

$410,128

Project duration

01/10/2007 to 30/09/2010

ACIAR Research Program Manager

Dr John Dixon

Website

<www.aciar.gov.au/project/CSE/2006/124>

LWR/2002/032: Integrated manure nutrient management in soybean–wheat cropping systems on vertisols in Madhya Pradesh and Queensland

Farmers in Madhya Pradesh, India, face large soil-nutrient deficits, resulting in the need for fertilisers to balance the soils. Farmyard manure (FYM) is plentiful and mainly used for fuel, as well as for fertiliser. More appropriate use could lessen the need for fertilisers. Farmers in south-eastern Queensland, Australia, already use FYM from feedlots on nearby fields. Inappropriate use can and, in some places, is resulting in excessive levels of nitrogen and phosphorus, as well as acting as a pollutant. What is needed in both locations is better FYM utilisation based on relevant management techniques. The complementary skills of farmers can be combined and transferred between locations to increase the levels of manure nutrients reaching crops and better balance fertiliser deficits while minimising environmental risks.

Overseas collaborating country

India

Commissioned organisation

University of Queensland, School of Land and Food Sciences, Australia

Project leader

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Collaborating institutions

BAIF Development Research Foundation, India
Department of Natural Resources and Mines, Queensland, Australia
Indian Institute of Soil Science, India

Project budget

$1,087,090

Project duration

01/07/2004 to 30/06/2010
(Project extended from 01/07/2008 to 30/06/2010)

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2002/032>

3.2 Subprogram 2: Water management and productivity for enhanced livelihoods in the rainfed areas of the central plateau, with emphasis on Andhra Pradesh

Better water management is one of the highest priorities for improving livelihoods in the more marginal rainfed areas of central India. Water harvesting, as part of a broader watershed development agenda to increase water availability, is a key policy initiative of the Government of India in these areas. While primarily designed to increase water productivity of crop and livestock production systems at both farm and watershed levels, widespread implementation of watershed development harbours risks of unintended hydrologic and socioeconomic impacts downstream; potentially risking some of the gains achieved in upstream areas.

Furthermore, water resources in rainfed areas are subject to some of the problems associated with common property; for example, weak water institutions and the lack of clear water rights and entitlements. This poses a challenge to program design, as addressing the above issues requires a systems approach spanning both spatial and temporal scales and the integration of biophysical and socioeconomic disciplines. Hence, this subprogram comprises a cluster of closely linked projects to enable a more holistic approach to water-resource management.

Given similar water constraints and policy challenges in many parts of Australia, including the semi-arid tropics, there is significant expertise in Australia to address water research issues from policy to crop–water productivity.

Project number	*Project title*
CIM/2007/120 (multilateral)	Improving post-rainy sorghum varieties to meet the growing grain and fodder demand in India (ICRISAT)
FIS/2002/001	Developing aquaculture in degraded inland areas in India and Australia
FIS/2006/144	Strengthening regional mechanisms to maximise benefits to smallholder shrimp farmer groups adopting better management practices
LWR/2002/100	Water harvesting and better cropping systems for benefit of small farmers in watersheds in the East India Plateau
LWR/2006/072	Impacts of meso-scale watershed development (WSD) in Andhra Prasesh, India, and their implications for designing and implementing improved WSD policies and procedures
LWR/2006/073	Assessing the feasibility of farmers managing climate-related crop production risk in Andhra Pradesh, India
LWR/2006/158	Enhancing institutional performance in water resource development in Andhra Pradesh, India
LWR/2008/015	Developing options to mainstream climate adaptation into farming systems in Cambodia, Lao PDR, Bangladesh and India

CIM/2007/120: Improving post-rainy sorghum varieties to meet the growing grain and fodder demand in India

Sorghum grown in India in the post-rainy season (Rabi) relies on residual soil moisture, and the crop is commonly exposed to terminal drought stress. But there is a ready market for its high-quality grain and stover (used as fodder on dairy farms). Steps to improve productivity while maintaining quality offer an attractive opportunity for sorghum farmers to improve their incomes. Genetically improving the efficiency of using stored soil moisture is a prime target to maximise grain/stover production and quality of Rabi sorghum. This project aims to achieve this through the application of DNA sequences known as quantitative trait loci (QTLs). The project scientists will introduce marker-assisted introgression of stay-green QTLs into sorghum lines, enhancing both the quality and the quantity of grain/stover of post-rainy sorghum. They will also use modelling to identify the key physiological traits involved in a higher, more stable yield across water-limited environments of India and Australia, and the key stay-green QTLs contributing to these traits. The publicly available QTL isolines developed in this project will be the basis of new varieties to be bred in a subsequent project phase.

Overseas collaborating country

India

Commissioned organisation

International Crops Research Institute for the Semi-Arid Tropics, India

Project leader

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Collaborating institutions

Department of Employment, Economic Development and Innovation, Australia
International Livestock Research Institute, India
National Research Centre for Sorghum, India
Queensland Department of Primary Industries and Fisheries, Australia
University of Queensland, Australia

Project budget

$1,003,620

Project duration

01/07/2008 to 30/06/2012

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2007/120>

FIS/2002/001: Developing aquaculture in degraded inland areas in India and Australia

Salinity and waterlogging, caused by rising watertables bringing both poor-quality (saline) and good-quality (waterlogged) water to the surface, are prevalent in parts of India and Australia. They render agricultural land unproductive or result in complicated management regimes to achieve viable yields. Utilising aquaculture in saline waters resulting from low aquifers, where water is pumped into holding ponds, is a possibility if properly managed. In India, project work is examining stocking densities and management techniques for rearing and growing-out giant freshwater prawns from the larval stage. In similar conditions in Australia, grow-out of snapper will be trialled and the suitability of saline groundwater for several prawn species will be examined. Suitable technologies for rearing these species will be trialled and developed.

Overseas collaborating country

India

Commissioned organisation

NSW Department of Primary Industries, Australia

Project leader

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Collaborating institutions

Central Institute of Fisheries Education, India
Indian Council of Agricultural Research, India
Murray Irrigation Limited, Australia

Project budget

$662,702

Project duration

01/01/2004 to 30/11/2009
(Project extended from 01/01/2008 to 30/11/2009)

ACIAR Research Program Manager

Dr Chris Barlow

Website

<www.aciar.gov.au/project/FIS/2002/001>

FIS/2006/144: Strengthening regional mechanisms to maximise benefits to smallholder shrimp farmer groups adopting better management practices

Better management practices (BMPs) in the aquaculture context outline norms for responsible farming of aquatic animals. In aquaculture, BMPs have been developed largely for shrimp and salmon aquaculture, although some efforts are presently being made to develop them for other aquatic commodities (e.g. tilapias, catfish, molluscs, eels). This project is building on the ongoing shrimp BMP programs in the Asia–Pacific region (e.g. in Australia, Indonesia, India, Vietnam and Thailand). It seeks to create a robust regional mechanism for networking and exchange of information—specifically focused to benefit small-scale shrimp farmers in Asia—to reduce disease risks, improve yields, produce good-quality shrimp, access better markets, address socioeconomic sustainability and comply with international principles.

Overseas collaborating countries

India, Indonesia, Thailand, Vietnam

Commissioned organisation

Network of Aquaculture Centres in Asia Pacific, Thailand

Project leader

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Collaborating institutions

Central Institute for Brackishwater Aquaculture, India
Department of Fisheries, Thailand
Directorate General Aquaculture, Indonesia
Marine Products Export Development Authority, India
National Fisheries Quality Assurance and Veterinary Directorate, Vietnam
University of Sydney, Australia

Project budget

$77,190

Project duration

01/06/2007 to 30/11/2009

ACIAR Research Program Manager

Dr Chris Barlow

Website

<www.aciar.gov.au/project/FIS/2006/144>

LWR/2002/100: Water harvesting and better cropping systems for the benefit of small farmers in watersheds of the East India Plateau

The East Indian Plateau, covering three Indian states, has a population of more than 27 million people, three-quarters of whom are rural. The plateau receives high rainfall, in excess of 1200 millimetres a year, but 80% of this falls in the monsoon months between June and September. Despite the high rainfall, water shortages are a problem, with high run-off and little, if any, water harvesting practiced. Cropping intensity is low, with only one crop per year, timed to maximise available water. By introducing watershed management, including water harvesting, and appropriate cropping and agronomic practices, opportunities to improve livelihoods in one of India's poorest regions should flow.

Overseas collaborating country

India

Commissioned organisation

University of Western Sydney, Australia

Project leader

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Collaborating institutions

Australian National University, Australia
ICAR Research Complex for Eastern Region, India
PRADAN, India

Project budget

$1,013,550

Project duration

01/10/2005 to 30/09/2009

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2002/100>

LWR/2006/072: Impacts of meso-scale watershed development (WSD) in Andhra Pradesh, India, and their implications for designing and implementing improved WSD policies and programs

Watershed development (WSD) programs in rainfed dryland agriculture in India have been introduced to ensure the sustainability of the surface and groundwater resources, and to improve the livelihoods of farmers. These programs have been applied at the micro-catchment or village level (up to 500 hectares). 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 5,000 hectares). 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. This project aims to quantify the aggregated impact of watershed interventions on hydrology within and across watersheds at meso-scale, to develop and apply integrated models to assess cost-effectiveness and water-related equity outcomes of stakeholder-defined watershed-development scenarios, and to integrate and (through partners) apply the knowledge arising from the project at local, state and national policy levels.

Overseas collaborating country

India

Commissioned organisation

Edith Cowan University, Australia

Project leader

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Collaborating institutions

Andhra Pradesh Farmer Managed Groundwater Systems (APFAMGS), India
Australian National University, Australia
Central Research Institute for Dryland Agriculture, India
Centre for Economic and Social Studies, India
CSIRO Sustainable Ecosystems, Australia
Department of Rural Development, India
International Water Management Institute, India
La Trobe University, Australia
Livelihoods and Natural Resource Management Institute, India
National Geophysical Research Institute, India
University of Ballarat, Australia

Project budget

$1,527,140

Project duration

01/06/2009 to 31/05/2014

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2006/072>

LWR/2006/073: Assessing the feasibility of farmers managing climate-related crop production risk in Andhra Pradesh, India

In the Indian state of Andhra Pradesh (AP), Kharif crops are heavily dependent on summer monsoon rains, where the timing and intensity of the rains affects crop yield. The majority of farms in AP are small and marginal, making them very vulnerable to yield reductions. Farmers also lack access to relevant information that might enable them to respond to seasonal conditions. Enabling farmers to utilise seasonal climate forecasting would allow them to respond to seasonal variability. To do this, farmers need a forecasting system that indicates a specific management strategy for the upcoming season, and effective and timely communication of the forecast information. Current agrometeorological advisories in AP are issued on a bi-weekly basis, and they are relevant to an agroclimatic-zone scale which may not be sufficiently relevant at a village level. Also, the information in the advisories may not be necessarily communicateded in a way that is relevant to the farmers' cropping decisions. The objectives of this project are to evaluate the skill of seasonal climate forecasts to be issued for the 2008 monsoon season, to assess crop management options in response to seasonal scenarios that capture the range of seasonal climatic variability, to develop and evaluate options for effective communication and adoption of climate forecasts and agricultural advisories, and to synthesise and report on options for future research investments into seasonal climate forecasting.

Overseas collaborating country

India

Commissioned organisation

CSIRO Sustainable Ecosystems, Australia

Project leader

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Collaborating institutions

Acharya N.G. Ranga Agricultural University, India
Central Research Institute for Dryland Agriculture, India
Department of Employment, Economic Development and Innovation, Australia
Queensland Department of Primary Industries and Fisheries, Australia

Project budget

$150,000

Project duration

01/02/2008 to 31/05/2009
(Project extended from 01/06/2009 to 31/12/2009)

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2006/073>

LWR/2006/158: Enhancing institutional performance in watershed management in Andhra Pradesh, India

Watershed development (WSD) programs, taken up under different schemes by the Government of India and various state governments, have been significant in raising productivity and incomes in rainfed areas of India. In WSD programs, technical water-harvesting solutions range from simple check-dams to large percolation and irrigation tanks, and from vegetative barriers to contour bunds. They can include in-situ soil and moisture conservation, agroforestry, pasture development and horticulture solutions. But field experience has shown that in a significant proportion of cases the farmers/villagers show low enthusiasm for adopting WSD technologies, and failures are common. Farmers and the village communities may show preference for indigenous technologies based on local knowledge which are cost-effective and simple but not ideal. There is great need for a new approach to these issues.

The aim of this project is to enhance livelihoods in rainfed areas of the Indian Central Plateau (particularly Andhra Pradesh), by improving the institutional performance of WSD programs. The project team will undertake a comprehensive evaluation of WSD program design and implementation in Andhra Pradesh. The desired outcome is greater capacity within various Indian agencies to improve institutional design for WSD and other resource-management activities. The project will also deliver on the social and environmental fronts by recommending rules and coordinating mechanisms for ensuring that the development and extraction of groundwater remain within sustainable limits. Conservative estimates based on earlier experience calculate that farmer incomes in Andhra Pradesh could be raised by about rupees (Rs)18,200 million (US$460 million) annually as a result of this project.

Overseas collaborating country

India

Commissioned organisation

La Trobe University, Albury-Wodonga Campus, Australia

Project leader

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Collaborating institutions

Andhra Pradesh Department of Rural Development, India
Department of Rural Development, India
Edith Cowan University, Australia
Indian Institute of Management, India
International Water Management Institute, India

Project budget

$815,920

Project duration

01/10/2008 to 30/09/2012

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2006/158>

LWR/2008/015: Developing options to mainstream climate adaptation into farming systems in Cambodia, Lao PDR, Bangladesh and India

Climate change impact is likely to be exacerbated where policy environments and capacity to respond are weak, and will amplify the current food-security crisis. This is the case in many Asian economies that heavily depend on agriculture. ACIAR plans to establish a dedicated climate change initiative, which is anticipated to proceed in two stages. Stage 1 will initially focus on farm-level adaptation research in India (particularly Andhra Pradesh state), Bangladesh, Cambodia and Laos, where there are considerable opportunities to build on past and ongoing ACIAR farming-systems projects. This small research activity will facilitate the scoping and design phase of Stage 1, leading into a 4.5-year program to commence in October 2009. The scoping team members will assess the constraints and opportunities to climate adaptation at the farm level in the four target countries. They will also assess, in the context of climate variability and climate change, the ability of selected farming-systems modelling tools to adequately capture biophysical and socioeconomic dimensions of rice-based cropping and mixed crop–livestock systems prevalent in the target regions. Finally, they will develop benchmarking methods and data collection (survey) protocols, providing a framework to assess impacts of adaptation. It is anticipated that this framework will undergo further development and testing in selected countries as part of this study.

Overseas collaborating countries

Bangladesh, Cambodia, India, Lao PDR

Commissioned organisation

CSIRO Sustainable Ecosystems, Australia

Project leader

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Project budget

$299,824

Project duration

01/12/2008 to 30/09/2009

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2008/015>

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

Creating the right policy environment for reform in the agricultural sector has the potential to deliver major impacts. Australia has significant expertise in policy analysis, particularly in assisting India with the implications of its transition from a highly regulated economy to a more open market economy. Large private retailers in India are poised to make large investments in the supply side to expand the already considerable agribusiness input supply sector, after having consolidated the retail sector. There is potential for enhanced Australian participation in the Indian food production chain through, for example, investment, collaboration and partnerships with Indian businesses, or export of Australian products and services. Possible benefits to Australia resulting from market reform include a capacity for India to engage in more open trade relations.

Project number	*Project title*
ADP/2007/062	Facilitating agricultural sector reforms in India: an assessment of regulatory and competition policy requirements
CSE/2006/132	Policy instruments to address air pollution issues in agriculture—implications for Happy Seeder technology adoption in India

ADP/2007/062: Facilitating efficient agricultural markets in India: an assessment of competition and regulatory reform requirements

A key priority of India's agriculture sector in the medium term is to develop agricultural-policy settings that enable farmers to efficiently adjust to a less regulated marketing environment. An earlier ACIAR project—ADP/2002/089 *Agricultural trade liberalisation and domestic market reforms in Indian agriculture*—found that trade-policy reform must be complemented by 'behind-the-border' reforms if the government is to meet objectives of improved productivity, higher rural employment and incomes and enhanced food security. This project, which follows on from the earlier study, will help ensure that the gains from international and domestic market reforms translate into real income gains for Indian farmers. The project will also provide a policy framework and ongoing guidance to policymakers in India in relation to the range of available competition-policy mechanisms and their application in particular circumstances.

Overseas collaborating country

India

Commissioned organisation

NSW Department of Industry and Investment, Australia

Project leader

Dr Scott Davenport
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Collaborating institutions

Australia New Zealand School of Government, Australia
La Trobe University, Australia
National Council of Applied Economic Research, India
University of Melbourne, Australia

Project budget

$401,289

Project duration

01/05/2008 to 31/10/2010

ACIAR Research Program Manager

Dr Simon Hearn

Website

<www.aciar.gov.au/project/ADP/2007/062>

CSE/2006/132: Policy instruments to address air pollution issues in agriculture—implications for Happy Seeder technology adoption in India

Burning is the normal method of rice residue (stubble) management in rice–wheat cropping systems in Punjab, north-western India. This has an extensive impact both on farm (through soil quality, air quality, biodiversity, and water and energy efficiency) and more broadly (through air pollution, greenhouse gas, biodiversity loss, and impacts on human and animal health). Air pollution is particularly severe, directly impacting on health, and also indirectly contributing to accidents through reduced visibility. An earlier ACIAR project developed a 'Happy Seeder' that is capable of direct drilling wheat into heavy rice-residue loads without prior burning. Preliminary financial evaluation of this technology indicates that it is financially viable for farmers, and financially preferable to alternative residue-management practices. However, existing policy settings may constrain the adoption of the Happy Seeder. This project will evaluate the economic, policy and social impact of the Happy Seeder, including looking at incentives to encourage adoption.

Overseas collaborating country

India

Commissioned organisation

NSW Department of Primary Industries, Economic Policy and Analysis Branch, Australia

Project leader

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Collaborating institution

National Council of Applied Economic Research, India

Project budget

$149,495

Project duration

01/06/2008 to 30/11/2009

ACIAR Research Program Manager

Dr John Dixon

Website

<www.aciar.gov.au/project/CSE/2006/132>

3.4 Other projects

The following projects are part of previous subprograms in India, however they are still active in 2009–10.

Project number	*Project title*
CIM/1999/062	Improving the quality of pearl millet residues for livestock
CIM/1999/072	Oilseed brassica improvement in China, India and Australia

CIM/1999/062: Improving the quality of pearl millet residues for livestock

Crop residues are a major source of ruminant feed in crop–livestock systems. To date, plant breeders have given little attention to the quality of this component of the crop. This project brings together plant breeders (ICRISAT) and livestock nutritionists (ILRI) to improve the quality of millet; a dual-purpose crop used widely by smallholder dairy farmers in India. About 70% of millet is grown using commercial hybrid cultivars, utilising ICRISAT parent lines. This project will introduce higher-quality attributes into some of the preferred parent lines and work with the private sector to conduct on-farm demonstrations of the new hybrids.

Overseas collaborating country

India

Commissioned organisation

International Crops Research Institute for the Semi-Arid Tropics, India

Project leader

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Collaborating institution

International Livestock Research Institute, India

Project budget

$1,220,010

Project duration

01/01/2004 to 31/12/2008

(Project extended from 01/07/2009 to 31/12/2009)

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/1999/062>

CIM/1999/072: Oilseed brassica improvement in China, India and Australia

China and India each grow over 6 million hectares of oilseed brassicas (*Brassica napus* is dominant in China and *B. juncea* dominant in India). Both countries seek to replace traditional rapeseed and mustard cultivars with canola quality types. They value Australia's canola quality *B. napus*, which is better adapted to their countries than varieties from Europe or Canada. But a number of key diseases and environmental stresses limit oilseed brassica production in India, China and Australia. This project will seek to develop *B. napus* and *B. juncea* germplasm with improved canola quality, disease resistance and improved drought tolerance. The project will generate genetic data on economically important traits in crosses between lines from Australian, India and China. Chinese and Indian scientists will improve their expertise in brassica quality analysis and molecular genetics through training opportunities in Australia.

Overseas collaborating countries

China, India

Commissioned organisation

University of Melbourne, Institute of Land and Food Resources, Australia

Project leader

Dr Phil Salisbury
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Collaborating institutions

Department of Agriculture, Western Australia, Australia
Department of Primary Industries, Victoria, Australia
Haryana Agricultural University, India
Huazhong Agricultural University, China
Indian Council of Agricultural Research, India
Institute of Industrial Crops, China
National Research Centre on Rapeseed-Mustard, India
New South Wales (NSW) Department of Industry and Investment, Australia
NSW Department of Primary Industries, Australia
Oil Crops Research Institute, China
Punjab Agricultural University, India
South Australian Research and Development Institute, Australia
Tata Energy Research Institute, India
University of Western Australia, Australia

Project budget

$2,607,090

Project duration

01/01/2004 to 31/12/2008
(Project extended from 01/01/2009 to 31/12/2009)

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/1999/072>

4 Projects expected to start in 2009–10

Project number	*Title*	*Countries*
CIM/2007/083	Applying molecular markers to breeding wheat with enhanced processing properties in India and Australia	India
CIM/2007/084	Molecular markers for broadening the genetic base of stem rust resistance genes effective against strain Ug99	India
LWR/2008/019	Building capacity of farming communities in Cambodia, Lao PDR, Bangladesh and India to adapt to climate change	Bangladesh Cambodia India Lao PDR
LWR/2009/040	Climate change meta analysis	Bangladesh Cambodia China East Timor India Indonesia Lao PDR Pakistan Papua New Guinea Philippines Vietnam

5 India chapter from the Annual Report 2008–09

5.1 Position

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

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

5.2 Achievements

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

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

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

ACIAR-funded research has contributed to the development of the 'Happy Seeder', an implement capable of direct drilling wheat into heavy rice-residue loads without prior

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

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

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

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

WSD programs have been significant in raising productivity and incomes in rainfed areas of India. In WSD programs, technical water-harvesting solutions range from simple check-dams to large percolation and irrigation tanks, and from vegetative barriers to contour banks. Field experience, however, has shown that in a significant proportion of cases the farmers/villagers show low enthusiasm for adopting WSD

technologies, and failures are common. Two projects are underway to enhance the livelihoods of farmers on the Central Plateau (particularly Andhra Pradesh) by improving the institutional and biophysical performance of WSD programs. These projects have, with the assistance of the Andhra Pradesh Department of Rural Development, established a sampling frame for assembling case data.

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

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

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

Other projects

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

Research is progressing in a project to improve post-rainy sorghum varieties to meet the growing grain and fodder demand in India. Sorghum grown in India in the post-rainy (Rabi) season relies on residual soil moisture, and the crop is commonly exposed to terminal drought stress. But there is a ready market for its high-quality grain and stover (used as fodder on dairy farms). Steps to improve productivity while maintaining quality offer an attractive opportunity for sorghum farmers to improve their incomes. Genetically improving the efficiency of sorghum is a prime target to maximise grain/stover production and quality of Rabi sorghum.

This project is working to improve the genetic efficiency of sorghum through the application of DNA sequences known as quantitative trait loci (QTLs) to use stored soil moisture. Genetic marker-assisted introgression of stay-green QTLs into sorghum lines

is being introduced, enhancing both the quality and quantity of grain/stover of post-rainy sorghum.

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

5.3 High-value harvest from saline groundwater

Salinity is a growing threat to crop productivity across many millions of hectares in India and Australia. Farmers strive to maintain production through management options such as pumping up the saline groundwater. But often they are fighting a losing battle, and large tracts of land formerly used to grow wheat and rice have become barren.

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

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

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

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

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

6 Projects concluded in 2008–09

ADP/2008/005: Viability of alternative frameworks for agricultural trade negotiations

The current World Trade Organization (WTO) framework is designed to reform and liberalise global trade in agriculture, however developing countries and Australia have not been well served by it. The framework's failure to deliver results has reduced farm incomes, aggravated problems of rural development and had negative spillover effects on international trade and political cooperation. This project looked at these problems and attempted to develop viable alternative frameworks for agricultural-trade liberalisation. It identified and examined new options for the negotiation of agreements on agriculture within the WTO. It also analysed the current state of agreement in the Doha Round of WTO trade negotiations, comparing the outcome with the opportunity that peer-reviewed economic models show would be available with more ambitious opening of world agricultural markets. In collaboration with the international partner institutions in Indonesia, India and China, the project identified the reasons for the poor prospects for the Doha Round.

Overseas collaborating countries

China, India, Indonesia

Commissioned organisation

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Project leader

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Collaborating institutions

Inquit Communications Pty Ltd, Australia
Strategic Asia, Indonesia
Indian Council for Research on International Economic Relations, India
Center for Chinese Agricultural Policy, China

Project budget

$149,700

Project duration

01/05/2008 to 30/04/2009

ACIAR Research Program Manager

Dr Simon Hearn

Project outcomes

In the last round of WTO multilateral trade negotiations (the Uruguay Round—1986 to 1993), disagreement over the treatment of agriculture delayed the conclusion of the talks by several years. Today, the current round of WTO negotiations (the Doha Round) is more than 6 years late in producing intended results—again, largely because

of serious disagreement among WTO Members over how to proceed with agricultural reform and liberalisation. The world clearly needs a more efficient and effective approach to dealing with this important sector of the global economy.

The primary focus of this project was to test the viability—from a political economy standpoint—of what is called the 'critical-mass' approach to trade negotiations addressing agriculture. Under the critical-mass approach, only those countries that account for the most significant trade shares of covered products participate in the negotiation and implementation of a deal. For example, a negotiation addressed to trade in wheat, soybean, maize and barley would need just 53 of WTO's 153 Members to cover more than 90% of global trade in these products. The benefit of the critical-mass approach is that small countries with a small interest in trade need not be involved so that the negotiation is less complicated and can therefore be concluded more rapidly with fewer concessions to special sensitivities.

In the first phase of the project—which benefited from the ACIAR funding—the research team developed some options for a critical-mass approach whose viability was tested by research collaborators in India, China, Brazil and Indonesia with industry groups, government officials and commentators in those economies. The findings of these contributors and the broad hypothesis of the principal researchers were then submitted for examination at a conference of experts held in Adelaide in late 2008. In broad terms, while most of those involved in the project think it would not be possible to introduce critical mass into the Doha Round at this late stage, there is considerable support for experimenting with the critical-mass approach for agriculture negotiations in the future.

In the second phase of the project—ongoing with financial support from the Australian Government's Rural Industries Research and Development Corporation (RIRDC)—the team is conducting a statistical and economic modelling exercise that will help us to understand the impacts of different options for a critical-mass agreement on different economies, regions and country income groups. The team also plans to compare the critical-mass approach with the current approach in the Doha Round (if it is ever unblocked). The results of this modelling of critical-mass 'packages' will be further tested in exchanges with experts and government negotiators later in 2009.

The project's capacity to prove the 'workability' of the critical-mass approach for agriculture could have an important positive impact on the way in which future negotiations are conducted. More rapid and effective negotiations to liberalise and reform agricultural trade will produce important welfare gains for farmers and consumers in both agricultural exporting countries and in countries that depend on imports to satisfy their food needs.

AH/1997/058: Increasing the productivity of cattle in India and Australia with rumen fungal treatments

Cattle are the most important providers of food (milk) from domesticated animals in India. Around 70% of India's one billion plus population rely on agriculture, with livestock husbandry usually carried out on smallholder farms. Crop residues along with other agricultural by-products provide much of the feed for cattle. Despite producing around 75 million tonnes of milk, India's annually demand cannot be met.

Increasing the productivity of ruminants can increase milk production and lessen the gap between demand and supply. Two options exist for achieving this increase: improving feed quality, or improving the ability of ruminants to utilise their dietary intake.

The first option, which relies on increased grain production or diverting available grains from human to animal diets, is unlikely in the short term. The second option involves treatments that help ruminants better digest and process the fibre component of dietary intake, achieved by improving the efficiency with which animals extract nutrients during the passage of feed through the gut. A flow-on effect of this would be improved milk production. This project investigated the efficacy of using fungal dosing to improve digestive extraction of nutrients, and the applicability of this approach in India.

The overall aim of the project was to improve the nutritional status in the rural poor by increasing the availability of milk in the diet. This would be achieved by providing dietary treatments which encourage greater utilisation of crop residues for milk production by large ruminants in smallholder units in India.

Overseas collaborating country

India

Commissioned organisation

CSIRO Livestock Industries, Long Pocket Laboratories, Australia

Project leader

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Collaborating institution

National Institute of Animal Nutrition and Physiology, India

Project budget

$718,392

Project duration

01/01/2003 to 28/02/2009
(Project extended from 01/07/2008 to 28/02/2009)

ACIAR Research Program Manager

Dr Doug Gray

Project outcomes

Two treatments were developed for improving the intake of poor-quality herbage by cattle. These treatments involved the use of a nutritional supplement (organic sulphur compounds) to selectively enhance fibre-degrading activity of anaerobic fungi in the rumen and a living fungal inoculant. In particular, positive responses in milk production occurred with lactating cows supplemented with the organic sulfur compound 3-mercapto-1-propanesulfonic acid (MPS).

The training, communication and collaboration between project teams have been highlights of this project. Four Indian scientists were trained in microbiology and molecular biology for 6 weeks each at the CSIRO laboratories. These training periods were then supported by strategic visits of an ACIAR-funded consultant, who provided critical advice on setting up new equipment in the laboratory and making it functional. The laboratory at the National Institute of Animal Nutrition and Physiology is now the equal or better than rumen microbiology laboratories around the world, both in facilities and functionality. The scientists are now in a position to undertake work of a high quality in a research field that is critical to countries where a large proportion of ruminant production is on low-quality feed—something that is becoming increasingly difficult to fund in developed countries where the emphasis is on human nutrition and health.

The project was favourably reviewed in 2007 and the external reviewer recommended that an extension be granted so that Australian scientists could further train the Indian scientists in molecular microbial techniques. Funding was subsequently provided by ACIAR to undertake a study involving the molecular fingerprinting of rumen microbial populations in cows supplemented with MPS. An Indian scientist visited Australia for training in molecular fingerprinting techniques for analysis of microbial populations. Equipment was installed in India to utilise these methods which are currently being applied to the analysis of rumen samples from cows supplemented with MPS.

The Australian and Indian partners have now sought alternative funding through an Australia–India International Science Linkage grant to continue aspects of the basic research.

FIS/2002/075: Application of PCR for improved shrimp health management in the Asian region

Shrimp farming, or culturing, is a profitable industry. Successful culturing provides income and employment for smallholder farmers, as well as those working in hatcheries, larger-scale farms, feed mills and processing plants. Most of this has flow-on effects as income is redistributed throughout the usually poor rural communities, many located in coastal regions that practice shrimp culturing.

In addition to these benefits, farming of shrimp is sustainable. This relieves the pressure placed on wild populations being harvested at unsustainable catch levels, motivated by reaping the potential income on offer. Thailand leads the world in farmed shrimp production, with Indonesia and India, like many other countries in Asia, both major and growing producers.

For the past decade, the Asian industry has been limited by disease outbreaks. Several have been serious enough to cause declines that if continued unabated would threaten the industry. Two diseases in particular, white spot syndrome virus (WSSV) causing white spot disease and yellow head virus (YHV) have caused these declines. Past ACIAR research has developed polymerase chain reaction (PCR) and epidemiological tests to identify the diseases. These are used to detect the viruses in seed-stock and live shrimp, respectively. Despite these being widely adopted, outbreaks continue, and a slow growth syndrome has become more prevalent, prompting further research into PCR use and its role in ongoing farm management.

The project focused on:

- reducing the risk of white spot disease in shrimp farms through the application of PCR-based detection tests and epidemiological probes
- reducing the risk of yellow head and other shrimp diseases in shrimp farms through application of PCR-based detection tests and epidemiological probes
- improving the effectiveness of PCR-based viral screening in hatcheries and service laboratories in India, Indonesia and other countries in the Asian region.

Overseas collaborating countries

India, Indonesia, Thailand

Commissioned organisation

CSIRO Livestock Industries, Australian Animal Health Laboratory, Australia

Project leader

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Collaborating institutions

Mahidol University, Thailand
Directorate General Aquaculture, Indonesia
Network of Aquaculture Centres in Asia–Pacific, Thailand
Agency for Marine and Fisheries Research, Indonesia

Project budget

$715,920

Project duration

01/01/2005 to 31/12/2008
(Project extended from 01/01/2008 to 31/12/2008)

ACIAR Research Program Manager

Dr Chris Barlow

Project outcomes

The first component of the project involved a series of three longitudinal studies conducted in Andhra Pradesh between 2005 and 2007. The first study (LS1) involved 427 best management practice (BMP) ponds in the West Godavari district. The second study (LS2) was conducted in the Krishna district in 61 ponds that were not yet enlisted in a BMP program. The third study (LS3) was conducted during the following crop in a cluster of 12 ponds within the same Krishna study site. The epidemiological studies indicated that, despite the use of seed that was largely free of WSSV, exposure to WSSV infection occurred during grow-out in each area, resulting in a high mean prevalence of WSSV infection and relatively high viral loads at the time of harvest or disease outbreaks.

In BMP ponds (LS1), the crop duration was higher and disease risk lower than in ponds in the non-BMP area (LS2 and LS3). Use of shared nursery ponds offered no advantage in terms of crop duration and may represent a high-risk source of disease amplification in the farming system. Exposure to WSSV infection often involved several genotypes in the same pond or in individual shrimp, and the prevalence of infection and viral loads generally increased as grow-out progressed.

Wild shrimp and crabs in ponds and surrounding canals were commonly infected with WSSV but there did not appear to be a direct link between WSSV genotypes in shrimp and those in co-inhabiting large crustaceans. There was evidence that dominant WSSV genotypes clustered in shrimp in adjacent ponds during disease outbreaks and that WSSV moved in 'waves' through sections of the farming system. Overall, the data supported use of in-pond nurseries rather than shared nursery ponds and indicated that BMPs must assume a high likelihood of exposure to WSSV, even when PCR-screened seed is used, placing greater emphasis on pond preparation and water-quality control to limit stress during grow-out.

The data also suggested that practices designed to exclude wild shrimp and crabs from ponds may not be essential and that greater emphasis should be placed on the management of water movements in farm clusters.

The second component of the project investigated the role of Laem-Singh virus as a possible cause of monodon slow growth syndrome. A survey of several farmed shrimp species indicated that the virus occurs commonly in healthy *Penaeus monodon* in India and South-East Asia, but not in Australia, but it is unlikely to be the cause of slow growth in *P. monodon* unless secondary epidemiological factors are involved in the syndrome.

The third component of the project provided an assessment of the proficiency of PCR service laboratories in India and Indonesia. Inter-laboratory calibrations provided intensive training in PCR for around 25 PCR technicians from service laboratories in each country, and developed the embedded capacity of collaborating institutions in PCR-based methods for diagnosis and research. Inter-laboratory calibrations provided clear evidence for the first time of very poor reliability of PCR testing in many service laboratories in both India and Indonesia. In India, collaborating institutions continued the inter-laboratory calibrations beyond the project completion and published their results, giving farmers the opportunity to select only those PCR laboratories that can perform well.

LWR/2001/014: Improving water-resource management in India's agriculture: search for effective institutional arrangements and policy frameworks

Water-resource management is critically important in India because of the growing demand for food and because the incomes and employment of 60–70% of Indians depend on agriculture. Irrigation is a key feature of India's agricultural strategy, but it is not being used to its potential. In fact, the excessive and indiscriminate use of water has often resulted in substantial harm to the soil and reduced productivity. Unfortunately, water-resource management in India is suffering. Surface-water management requires heavy investment including meeting technical needs and environmental concerns. Groundwater management must reduce excessive pumping and address inadequate recharge of the watertable. There are simple, well-known technical and economic solutions to the problems, but institutional arrangements are complex and need support.

There is an urgent need to develop better and more socially acceptable institutional arrangements. This project identified institutions and policies that would promote the efficient and sustainable management of water resources in India. In the past 15 years, Australian water managers have accumulated a wealth of information on water institutions and legal reforms. As in India, Australian water-management institutions must deal with several levels of government as well as different types of water use and water users. The lessons learned from the Australian experience were tested for applicability in the Indian situation.

Overseas collaborating country

India

Commissioned organisation

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Project leader

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Collaborating institutions

Indian Institute of Management, India
University of South Australia, Australia
Deakin University, Australia

Project budget

$401,337

Project duration

01/07/2002 to 31/12/2008
(Project extended from 01/07/2008 to 31/12/2008)

ACIAR Research Program Manager

Dr Mirko Stauffacher

Project outcomes

This project has tackled important problems in water policy for Australia and India in a systematic way. As early as the preliminary workshop in Beechworth, Australia, in 2003, a logical basis for considering the features of successful irrigation institutions was developed, emphasising clear objectives, good (internal) interaction, flexibility to adapt, appropriateness of scale (particularly spatial and administrative) and compliance ability (with respect to internal and external controls).

In many parts of both countries, extraction of water from regulated and unregulated waterways and groundwater is greater than sustainable yield. That outcome should not be judged an unfortunate accident or result of unavoidable circumstances but has more to do with serious deficiencies in institutions and administration. The project has successfully incorporated insights from recent developments in institutional economics and explored the conditions under which improvements in administration can occur.

The major contribution of the project has been through detailed surveys of institutional arrangements in the Indian states of Gujarat, Maharashtra and Andhra Pradesh. Water scarcity is a characteristic of all these states. Different mixes of water institutions exist—for example, groundwater institutions and check-dams are more prevalent in Gujarat and canal and river-lift cooperatives in Maharashtra state. Altogether, 440 households were sampled including members and officials in the institutions with coverage of head-end, middle and tail-end irrigators (for canal irrigation).

The results of the surveys broadly confirm the predictions of new institutional economics with clarity of objectives, good interaction and adaptability explaining success and failure of institutions. Performance of institutions varied between institution type and state but not according to surface water or groundwater.

The overall outcome of the project is productive research collaboration. Important research findings that could assist resolution of dilemmas facing policymakers in irrigation management in India and Australia include:

- there needs to be devolution of power in irrigation management
- where people have had responsibility for their own affairs, there has been some success provided there is sufficient integration with the body above
- there are regional differences within India suggesting that a ‘one shoe fits all’ approach would not work
- in some situations, there has been a lack of capacity to handle irrigation management, suggesting a need for government intervention.

Broadly, the dilemma faced by policymakers in both countries is ongoing water scarcity in terms of the demands placed on it. Demand for water is running ahead of sustainable yield. For India, shortage of water is related mainly to demand for water for irrigation. In Australia, there is a new source of demand for water from those interested in (non-consumptive) environmental attributes of rivers and streams. In both cases, current institutional arrangements have failed so far to deliver a satisfactory solution. Neither group of researchers has direct access to the policymaking process, suggesting that implementation of research findings rely on the intellectual strength of their arguments and quality of communication to a wider audience rather than insider influence.

LWR/2003/026: Water allocation in the Krishna River Basin to improve water productivity in agriculture

India's Krishna River Basin covers an area in excess of 250,000 square kilometres, or around 8% of India's land mass. The basin is shared between three large central states, Karnataka, Maharashtra and Andhra Pradesh. Demand for water, driven by population growth, is increasing; agriculture represents 95% of demand, while industry (2%) and domestic use (3%) account for the rest. Water allocations in the basin have been based on the rulings of the 1969 Krishna Water Disputes Tribunal. Since that time, the basin's water use has focused on crop irrigation in the semi-arid central region, diverting water from the Krishna Delta 'Rice Bowl'. River flows to the ocean have ceased; a situation that mirrors what has occurred in Australia's Murray–Darling Basin. This similarity, along with questions of water consumption for agriculture as opposed to use for environmental flows, have been addressed in Australia. The Indian Parliament has reconstituted the Krishna Basin Tribunal to negotiate the balance of flows and allocations for the next 4–5 years. The tribunal's challenge is to provide the relevant information to ensure decision-making results in sustainability and caters to the needs of a growing population while not exceeding levels of likely supply. This project aimed to provide technical and economic information and decision support to the Central Water Commission and Ministry of Water Resources, as advisory agents to the Krishna Basin Tribunal, to help improve water productivity for agriculture in these three riparian states of the Krishna Basin.

Overseas collaborating country

India

Commissioned organisation

International Water Management Institute, Hydrology and Water Resources, India

Project leader

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Collaborating institutions

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University of Melbourne, Department of Civil and Environmental Engineering, Australia

Project budget

$1,393,617

Project duration

01/07/2004 to 30/06/2009
(Project extended from 01/07/2008 to 30/06/2009)

ACIAR Research Program Manager

Dr Mirko Stauffacher

Project outcomes

This project originally aimed to model the water resources of the whole of the Krishna Basin in order to assess the hydrologic and economic impact of water reallocation of regulated flows in the basin, and to undertake a limited assessment of water policy in

the Murray–Darling Basin. A major policy intervention in Krishna Basin at the time of inception of the project was the formation a water resources tribunal in Krishna to help resolve water-allocation issues between the three riparian states in the basin.

However, the project encountered problems in gaining access to key data sets for the basin-level analysis and in securing full cooperation at all levels. Therefore, ACIAR agreed to a project-team request to focus the project effort in three individual subbasins (or catchments) selected as focus areas in the three states, each with a different set of characteristics. These were the Musi in Andhra Pradesh, the Upper Bhima in Maharashtra and the Malaprabha in Karnataka. Each focus catchment has a different hydrology and faces different water resources management issues.

It was also decided to carry out state-level water accounting to help provide the management links with the state water authorities. In the revised project, the International Water Management Institute (IWMI) was in principle responsible for collecting, collating and analysing hydrologic data on a state-wide basis, to help provide the basin-wide water balances using the Water Evaluation and Planning (WEAP) framework, and for undertaking surface–groundwater interaction analysis at the subbasin level using the hydrogeologic analysis and MODFLOW modelling framework. The detailed hydrologic and economic analysis and scenario integration work was the responsibility of the University of Melbourne with considerable experience in the application of the Resource Allocation Model (REALM) at the subbasin level.

While the project could not achieve a whole-of-basin analysis, it made excellent progress in showing the benefits of integrated hydrologic economic analysis—especially for the Musi subbasin and with varying degrees of progress for the other subbasins and at the state level. While the revised approach made it possible to analyse stock and flows of water at the subbasin level, it did not provide a whole-of-basin perspective in terms of capturing flow-on effects of policy decisions of changing water supply and demand. Similarly, the change of focus at the state level so far has not established links between the detailed and course hydrologic analysis at the subbasin and the catchment levels.

The project team is initially finishing the Musi analysis followed by the Malaprabha and the Upper Bhima. In this process, stakeholder inputs to help complete the scenario analysis have started to flow. It appears that project has started to attract greater engagement with the state governments in terms of sharing of data and results and thus the team needed further time to finish the subbasin scenario analysis and state-wide water accounting to desired level of detail.

A 1-year extension of the project enabled the team to complete the analysis, apply the models empirically and facilitate the uptake of the project outputs by policymakers. The main project activities during the extension period were to:

- finalise the existing hydro-economic subbasin- and state-scale models
- apply the models to a suite of end-user-defined water-resource allocations
- gain acceptance of the modelling outputs amongst state and federal policy makers

The models can and have been used to simulate scenarios for the Musi subcatchment that included supplying future urban water requirements from the Nagarjuna Sagar reservoir, implementing water-harvesting structures, various climatic effects and changing cropping patterns.

Following a visit by a high-level delegation of water-resource department officials from Karnataka, Maharashtra and Andhra Pradesh to Australia, the Maharashtra Secretary of Water Resources, Mr Gaikwad, requested that the ACIAR Krishna Basin team assist his ministry with the state's water policy and help out with a water audit of the Maharashtra part of the Krishna Basin.

Pakistan

7 Pakistan chapter from the Annual Operational Plan 2009–10

7.1 Medium-term strategy

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

7.2 The Australia–Pakistan Agriculture Sector Linkages Program (ASLP)

The main goals of the agriculture linkages component are to:

- transfer Australian knowledge and expertise to key sectors of Pakistan agribusiness to increase profitability and enhance export potential
- contribute to poverty alleviation of smallholder farmers through collaborative research and development
- enhance the capacity of the Pakistan research, development and extension systems to deliver targeted and practical research outputs to agribusiness and farmers.

It has been agreed to target the following priorities for technical support:

- increasing mango and citrus production, through diagnosis and control of diseases and orchard management, to increase productivity and reduce input costs
- enhancing the supply chain, including value-adding and marketing, for the mango and citrus industries
- increasing milk production from individual animals in the dairy sector.

To meet the ASLP goals and ensure it delivers early impacts, the program comprises initial short-term scoping studies and constraints analysis; information exchange and exposure to agroenterprises through visits to Australia; technical and scientific workshops; tailored training and capacity building; and research and development projects. The main anticipated outcome of the ASLP is to build stronger capacity in Pakistan to exploit agribusiness opportunities in the targeted sectors, with the dual purposes of underpinning the current high growth rates in the agricultural sector and contributing to poverty reduction. The current phase of the ASLP runs until March 2010. Following a review in early 2009, an extension of the program through to March 2014 has been recommended.

7.3 Key performance indicators (2009–10)

- productivity gains in horticultural and dairy enterprises leading to higher farmer incomes in selected areas
- improved quality of mangoes achieving higher export volumes and revenues
- new generation resource conserving technologies and conservation tillage machinery increasingly adopted through the support of Government of Pakistan programs.

7.4 Position

Pakistan has been an ACIAR partner country since 1984. Increasing pressure on availability of water resources for irrigation exists due to competing demands from urban and industrial uses. Soil and water salinity and drainage problems are placing additional pressure on irrigated agriculture. Given the similarity of some of its own water resource and salinity issues, Australia is well placed to assist Pakistan in addressing these issues. ACIAR's program continues to focus on irrigation, drainage and salinity management in the major cropping systems.

In addition, there is recognition that Australia has skills for working with some of Pakistan's key horticultural crops, especially citrus and mangoes, the two most important tree crops. Australian expertise can provide a whole-of-system approach to increase the productivity and competitiveness of the mango and citrus industries, encompassing all steps from fruiting to market. Pakistan is also one of the world's largest milk producers, with slightly less than half of that production from dairy cattle. Unit animal production is very low although genetic potential is quite good. Major opportunities exist for applying Australian expertise in animal nutrition and integrating forage production into farming systems to assist in improving milk production. This work is a key to poverty reduction, particularly for some of Pakistan's landless people. The geographical focus in ACIAR's Pakistan program, including work carried out under the support of the ASLP, is on Punjab, Sindh and North-West Frontier provinces.

7.5 Research priorities

The most recent formal consultations were held in November 2008 during the review of the ASLP. All new projects in Pakistan will include significant components of capacity building in participatory research and extension methodologies.

Indicative priorities are grouped under the following themes:

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

- Diagnosis and control of diseases, especially dieback in mango
- Orchard management to increase productivity and reduce input costs
- Optimisation of supply chains to increase value-adding and marketing opportunities
- Support of linkages between farmers and the private agribusiness sector
- Analysis of policies underpinning development of the horticultural sector.

Subprogram 2: Improving livelihoods of dairy farmers

- Increase in unit productivity of dairy cattle though improved nutrition
- Support of linkages between farmers and the private agribusiness sector
- Analysis of policies underpinning development of the dairy sector.

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

- Introduction of strategies to optimise the value of limited and variable-quality irrigation water
- Technology selection to improve productivity of saline land and water resources

- Use of resource-conserving technologies for irrigated horticultural and cereal-based farming systems.

7.6 Relationship to the Australian Development Cooperation Framework for Pakistan

A new Development Cooperation Framework for Pakistan is under development during 2009–10. In line with an increased focus on helping the Government of Pakistan get back on track to achieve the Millennium Development Goals, priority sectors for Australian support are primary education, basic health, natural-resources management and poverty reduction in provinces bordering Afghanistan and North-West Frontier province. The ACIAR program, while concentrating on the agricultural sector, includes a strong emphasis on reducing vulnerability and increasing productivity of the poor. The Pakistan program also addresses increased productivity in selected agricultural sectors as well as management of the natural-resources base.

8 Active projects in Pakistan

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

The horticulture sector in Pakistan is significant both domestically and for export production. A problem common to both mango and citrus is major losses due to poor harvesting practices, packing and transportation. With production, key issues are inadequate orchard and irrigation/drainage management, and major diseases. Australia has strengths in mango and citrus that span the production system and supply chain, in particular the use of a systems approach and integration of end users in the planning, execution and evaluation of the research. These are unique attributes that could be employed in Pakistan, and promise significant opportunities for impacts on productivity and more efficient supply-chain systems. The ASLP will aim to capitalise on this by linking the Australian and Pakistan research teams with the agribusiness sector and introducing participatory activities with farmers.

Project number	*Project title*
HORT/2005/153	Development of integrated crop management practices to increase sustainable yield and quality of mangoes in Pakistan and Australia
HORT/2005/157	Optimising supply chains for more profitable horticultural agro-enterprises in Pakistan and Australia
HORT/2005/160	Increasing citrus production in Pakistan and Australia through improved orchard management techniques

HORT/2005/153: Development of integrated crop management practices to increase sustainable yield and quality of mangoes in Pakistan and Australia

The sustainable development of the mango industry in both Pakistan and Australia is hampered by a shortage of high-quality fruit for export. In addition to postharvest handling and storage, disease and pest losses, variable productivity due to orchard management issues and market access challenges constrain mango industry development. This project seeks to: establish 'clean' mango nurseries so that high-quality planting material is made widely available to the Pakistan industry; develop improved tree husbandry and management options to produce sustainable yields and quality fruit; develop improved detection and management strategies for mango sudden death disease syndrome (MSDS) and other major diseases of mangoes, and to build research capacity in the mango industry.

Overseas collaborating country

Pakistan

Commissioned organisation

Department of Employment, Economic Development and Innovation, Australia

Project leader

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Collaborating institutions

Ayub Agricultural Research Institute, Pakistan
National Integrated Pest Management Programme, Pakistan
Agriculture Research Sindh, Pakistan
Institute of Plant and Environmental Protection, Pakistan
International Center for Agriculture Research in the Dry Areas, Pakistan

Project budget

$1,049,930

Project duration

01/01/2007 to 31/12/2009

ACIAR Research Program Manager

Mr Les Baxter

Website

<www.aciar.gov.au/project/HORT/2005/153>

HORT/2005/157: Optimising mango supply chains for more profitable horticultural agroenterprises in Pakistan and Australia

Much of Pakistan's fruit and vegetable production, including mangoes, is not fully utilised due to poor harvesting, handling and other postharvest practices. This project will address key constraints currently limiting the efficiency, effectiveness and competitiveness of supply chains for Pakistan mangoes. It aims to improve and maintain mango quality from harvest to consumption by identifying present market needs and likely future opportunities for Pakistan mangoes, through analysis of existing supply chains and the development of improved supply-chain management systems and practices.

Overseas collaborating country

Pakistan

Commissioned organisation

University of Queensland, School of Natural and Rural Systems Management, Australia

Project leader

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Collaborating institutions

Department of Agriculture and Food, Western Australia, Australia
Pakistan Horticulture Development and Export Board, Pakistan
Queensland Department of Primary Industries and Fisheries, Australia
University of Agriculture Faisalabad, Pakistan
Department of Employment, Economic Development and Innovation, Australia

Project budget

$1,271,020

Project duration

01/12/2006 to 30/11/2009

ACIAR Research Program Manager

Mr Les Baxter

Website

<www.aciar.gov.au/project/HORT/2005/157>

HORT/2005/160: Increasing citrus production in Pakistan and Australia through improved orchard management techniques

Pakistan has set an annual export target for citrus of 500,000 tonnes within the next 5 years, and $300 million in export earnings by 2013, but some key constraints need to be addressed to achieve these ambitious targets. This project arose from an ACIAR-supported scoping study in which key constraints to a more productive citrus industry in Pakistan were identified, and a schedule drawn up to address them. Its principal aim is to improve mandarin and orange productivity in Pakistan and Australia through improved nursery production practices and production, demonstration of 'best practice' orchard management, and enhanced research, extension and production capacity of Pakistan citrus institutions and industry.

Overseas collaborating country

Pakistan

Commissioned organisation

NSW Department of Industry and Investment, Australia

Project leader

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Collaborating institutions

Institute of Plant and Environmental Protection, Pakistan
Orange Research Institute, Pakistan
Horticulture Research Institute, Pakistan
Agricultural Research Institute, Pakistan
CABI South Asia Regional Centre, Pakistan
International Center for Agriculture Research in the Dry Areas, Pakistan
University of Agriculture, Faisalabad, Pakistan

Project budget

$651,342

Project duration

01/04/2007 to 31/03/2010

ACIAR Research Program Manager

Mr Les Baxter

Website

<www.aciar.gov.au/project/HORT/2005/160>

8.2 Subprogram 2: Improving livelihoods of dairy farmers

Dairy is the largest livestock sector in Pakistan, with demand for milk and milk products growing at about 8% per annum. Despite good genetic potential among animals, production is low due to poor nutrition, mismanagement, failure to control diseases, and lack of proper marketing of this highly perishable commodity. This is compounded by a fragmented research effort and weak extension-support services. The ASLP will support Government of Pakistan initiatives to stimulate the dairy sector. The program will integrate activities and concentrate on mechanisms to increase individual animal production, principally through nutrition. It will have a strong systems focus and an emphasis on capacity building in extension strategies. The issues likely to be considered in this approach include social, economic and biophysical analysis of farming systems, development of seasonal feeding options, the introduction and evaluation of forages, and feed conservation strategies.

Project number	*Project title*
LPS/2005/132	Improving dairy production in Pakistan through improved extension systems

LPS/2005/132: Improving dairy production in Pakistan through improved extension services

Milk supply in Pakistan has increased by more than 5% per annum over the past 15 years, but demand is anticipated to more than treble by 2020. An effective extension service can contribute to reform of the industry, but at present there are too few extension officers, and they typically receive inadequate training. This project, conducted under the auspices of the Australia–Pakistan Agriculture Sector Linkages Program (ASLP), is designed to demonstrate the economic and social benefits of improved extension services to smallholder dairy farmers. It will achieve this by enhancing the scope and quality of information used for training extension personnel and lifting the research capacity of Pakistani scientists to contribute to the development of the dairy sector.

Overseas collaborating country

Pakistan

Commissioned organisation

Charles Sturt University, Australia

Project leader

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Collaborating institutions

National Rural Support Program, Pakistan
Livestock and Dairy Development Department, Pakistan
Livestock and Dairy Development Board, Pakistan
Idara-e-Kissan, Pakistan

Project budget

$1,197,730

Project duration

01/07/2007 to 31/12/2009
(Project extended from 01/01/2010 to 30/03/2010)

ACIAR Research Program Manager

Dr Peter Horne

Website

<www.aciar.gov.au/project/LPS/2005/132>

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

Irrigated land supplies more than 90% of agricultural production in Pakistan. The main canal system and its secondary-level canals are managed at a provincial level by central irrigation agencies. A recently introduced reform process is designed to shift the management of irrigation at local (tertiary) levels to water-user associations. The aim is to address some of the multiple problems of irrigation systems such as inequitable water distribution, high conveyance losses, low delivery efficiency, waterlogging and salinisation.

Increasing competition for water by non-agricultural users will put additional strain on the systems, and there are uncertainties about future water supply as a result of climate change. Australia, facing similar problems with its irrigation systems, has developed strong irrigation and water-resources research expertise. In the future, the cluster of projects in this subprogram is expected to have substantial linkages with the horticulture and dairy sectors, while improving the overall performance of the irrigation sector in Pakistan. There will also be ongoing support to promote raised-beds technology as a promising on-farm technique to reduce irrigation water usage.

Project number	*Project title*
CIM/2003/067 (multilateral)	Ensuring productivity and food security through sustainable control of yellow rust in wheat in Asia (CIMMYT)
LWR/2002/034	Refinement and adoption of permanent raised-bed technology for the irrigated maize–wheat cropping system in Pakistan
LWR/2005/144	Optimising canal and groundwater management to assist water-user associations in maximising crop productivity and managing salinisation in Pakistan and Australia

CIM/2003/067: Ensuring productivity and food security through sustainable control of yellow rust of wheat in Asia

Losses of wheat crops from cereal rust diseases are a major threat to food security. Yellow rust (*Puccinia striiformis* f. sp. *tritici* or Pst) affects wheat in most conditions and is therefore a major threat throughout Asia. Yellow rust's causal agent (Pst) is capable of rapid evolution into new wheat races and of migrating long distances on the wind. Host-plant resistance is the main control, but breakdowns of resistance in China, Pakistan and elsewhere in central and western Asia have recently occurred. Resistant gene isolines will be used to monitor Pst virulence in Asia as an early warning system against further outbreaks. These isolines will also be used to help identify resistance genes for introduction into new cultivars.

Overseas collaborating countries

Afghanistan, Bangladesh, China, India, Pakistan

Commissioned organisation

International Maize and Wheat Improvement Center, Mexico

Project leader

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Collaborating institutions

University of Sydney, Australia
International Center for Agricultural Research in the Dry Areas, Syria

Project budget

$1,000,050

Project duration

01/01/2005 to 31/12/2009

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2003/067>

LWR/2002/034: Refinement and adoption of permanent raised-bed technology for the irrigated maize–wheat cropping system in Pakistan

In Pakistan, the practice of irrigated maize–wheat cropping on permanent raised beds has been shown to save water and increase yields (LWR/1998/131). In Western Australia's dryland cropping, the potential benefits of raised-bed cropping were inconclusive. Irrigated cropping dominates Pakistan's agriculture. Despite this, grain yields are low and water is used inefficiently. Salinity and sodicity are on the rise. New research will seek to optimise the raised-bed system in Pakistan. This will focus on soil management and impacts caused by the new system, and the 'best-bet' technology for raised beds, including low-cost machinery. Cluster groups will be involved in seeking adoption. In Western Australia, the role of beds in saline conditions will be modelled for potential benefits.

Overseas collaborating country

Pakistan

Commissioned organisation

Department of Agriculture and Food, Western Australia, Australia

Project leader

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Collaborating institutions

Pakistan Agricultural Research Council, National Agriculture Research Centre, Pakistan
Ministry for Food, Agriculture and Land, Pakistan
National Agricultural Research Council, Pakistan
University of Southern Queensland, Australia
University of South Australia, Australia

Project budget

$848,352

Project duration

01/01/2004 to 31/12/2006
(Project extended from 01/10/2008 to 31/03/2010)

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2002/034>

LWR/2005/144: Optimising canal and groundwater management to assist water-user associations in maximising crop production and managing salinisation

The Punjab Irrigation and Drainage Authority in Pakistan operates and maintains one of the largest irrigation canal systems in the world. However, the system now requires major rehabilitation and improvement to meet present-day demands. Recent analyses show that the inequity of water distribution between head-enders and tail-enders is closely correlated to decreasing yields and increasing salinity with increasing distance from the canal. This project will identify opportunities for equitable distribution of canal and groundwater to improve livelihoods through maximising crop production and managing salinisation in irrigated landscapes. The project team will develop tools capable of analysing hydrological and economic water-management trade-off scenarios, use the results to develop improved canal and groundwater management options, then give support in implementing the improvements.

Overseas collaborating country

Pakistan

Commissioned organisation

Charles Sturt University, International Centre of Water for Food Security (IC Water), Australia

Project leader

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Collaborating institutions

University of Agriculture Faisalabad, Water Management Institute, Pakistan
Punjab Irrigation and Drainage Authority, Programme Management and Implementation Unit, Pakistan

Project budget

$1,000,000

Project duration

01/01/2008 to 31/12/2011
(Project extended from 01/01/2012 to 31/12/2012)

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2005/144>

9 Projects expected to start in 2009–10

Project number.	*Title*	*Countries*
LWR/2009/040	Climate change meta analysis	Bangladesh Cambodia China East Timor India Indonesia Lao PDR Pakistan Papua New Guinea Philippines Vietnam

10 Pakistan chapter from the Annual Report 2008–09

10.1 Position

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

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

10.2 Achievements

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

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

Much of Pakistan's fruit and vegetable production, including mangoes, is not fully utilised, due to poor harvesting, handling and other postharvest practices. A project is addressing key constraints currently limiting the efficiency, effectiveness and competitiveness of supply chains for Pakistan mangoes, examining ways to improve and maintain mango quality from harvest to consumption. The project is identifying present market needs and likely future opportunities for Pakistan mangoes, through analysis of existing supply chains and the development of improved supply-chain management systems and practices. Experiments have addressed the issues of

optimum storage, ripening procedures, assessment of harvest maturity and identification of postharvest diseases for the two main commercial mango cultivars (Chaunsa and Sindhri). Along with these trials, a hot-water treatment (HWT) assessment, which was not in the original plan, also took place to facilitate mango export to countries that require HWT disinfestation. In 2007, China was identified as a potential market for Pakistan mangoes. In September 2008, two groups of four final-semester undergraduates of the University of Queensland's Agribusiness program took 40 kilograms of Pakistani Chaunsa mangoes to Beijing and Guangzhou to evaluate the market response. Their findings are being used as the basis for a commercial trial shipment to China.

Pakistan has set an annual export target for citrus of 500,000 tonnes within the next 5 years, and $300 million in export earnings by 2013, but some key constraints need to be addressed to achieve these ambitious targets. A project aims to improve mandarin and orange productivity in Pakistan and Australia through improved nursery production practices and production; demonstration of best-practice orchard management; and enhanced research, extension and production capacity of Pakistan citrus institutions and industry.

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

Subprogram 2: Improving livelihoods for dairy farmers

In spite of the importance of the dairy industry to Pakistan's economy and food supply, the productivity of buffalo/cows owned by smallholder farmers dependent on an income from three to ten head is poor by world standards. Much of the technology required to boost efficiency is available but is not readily disseminated, nor adopted by the farming community. A project is demonstrating the economic and social benefits of improved extension services to smallholder dairy farmers, and also collecting, enhancing and disseminating knowledge relevant to smallholder dairy systems. A baseline longitudinal survey is providing information on existing farm practices, feeding regimes, milk production and husbandry practices across 200 farms. Training has been provided for field extension workers and cooperating farmers, who have been introduced to the principles of feed and water management, cow health, calf rearing and reproductive management. The longitudinal survey has allowed the project team to monitor the impact of change in farming practices on productivity and farm income. The results of this survey will be important in providing a benchmark for future operations.

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

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

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

11 Projects concluded in 2008–09

LWR/2004/035: Technology for direct drilling into rice and other heavy stubbles in Pakistan and Australia

Burning is the normal method of rice-stubble management in the 2 million hectares of rice–wheat systems of Pakistan, and in the 0.15 million hectares of rice-based cropping systems of southern Australia. In southern Australia, most irrigated wheat and 50% of maize stubbles are also burnt. Stubble burning causes air pollution (particulates, greenhouse gases), nutrient loss (especially nitrogen and carbon; also phosphorus, potassium and sodium) and soil organic-matter decline. In Pakistan, air pollution from stubble burning is particularly bad, impacting on human health.

Until recently, there has been no machinery capable of direct drilling into rice stubble and achieving consistently good results, due to problems of clogging of toolbars with the loose residues and hair pinning. These problems were recently overcome with the development of the 'Happy Seeder' concept, which involves cutting and picking up the stubble, sowing into bare soil, and mulching with the stubble in a single operation. In 2002, the Happy Seeder was conceived, designed, built and tested by John Blackwell (CSIRO Land and Water) at Punjab Agricultural University, India through ACIAR project SMCN/2000/89. The first Happy Seeder consisted of a seed drill attached to the rear of a forage harvester, which cuts the stubble and deposits it behind the seed drill. In 2003, Shabbir Khan and team (Pakistan Agricultural Research Council) designed and built the 'FMI seeder' which combines the flail chopping, sowing and mulching operations into a single compact machine. In 2004, a 4-metre wide version of the Happy Seeder suited to broadacre conditions in Australia was designed and built by John Blackwell, with funding from Twynam Pastoral Co. Pty Ltd.

While the problem of sowing into heavy residues has almost been solved mechanically, our experience to date in India shows that there are some design parameters and agronomic management practices that need to be refined to achieve good establishment and crop performance with the Happy Seeder approach. These include evenness of spreading of the mulch, amount of mulch through which a crop can establish, sowing depth, soil moisture at sowing, soil type and irrigation and nitrogen (N) management. There is clearly a need to evaluate and refine the technology for a range of stubble, soil and seasonal conditions, and to develop guidelines for achieving reliably good establishment, efficient use of N fertilizer and high yields in rice–wheat and alternative cropping systems.

The objectives of the project were to:

- evaluate and refine the FMI seeder in Pakistan, and the Twynam Happy Seeder in Australia, for direct drilling into rice and other heavy stubbles
- enable the manufacture of FMI seeders in Pakistan, and to extend the uptake of the new direct drilling technology by farmers in Pakistan and Australia.

Overseas collaborating country

Pakistan

Commissioned organisation

CSIRO Land and Water, Australia

Project leader

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Collaborating institution

Pakistan Agricultural Research Council, Farm Machinery Institute, Pakistan

Project budget

$399,998

Project duration

01/10/2005 to 28/02/2009
(Project extended from 01/10/2008 to 28/02/2009)

ACIAR Research Program Manager

Dr Mirko Stauffacher

Project outcomes

Major benefits of direct drilling with mulching in comparison with direct drilling with stubble burning in Pakistan will include higher yields from reduced turnaround time between rice harvest and wheat sowing and from conservation of soil water, and improved air quality. In both regions, there will be immediate benefits of reduced costs (irrigation water, herbicides) and reduced greenhouse gas emissions, and medium- to long-term benefits of improved soil structure and nutrient status which will translate into reduced fertiliser costs. In Australia, application of the technology will also increase the opportunity for double cropping.

PLIA/2006/136: Economic and policy constraints affecting the development of small-scale dairy farmers in Pakistan

Industry development in the smallholder dairy sector in Pakistan has been hampered by inadequate feeding and low milk yields, low milk prices and constraints on milk marketing and distribution, and institutional and regulatory issues at all levels of government. This small research activity has been designed to link with ACIAR project LPS/2005/132 *Improving dairy production in Pakistan through improved extension services* and addresses the technical issues that cause farm performance deficiencies in the smallholder sector. Its focus was to identify the economic constraints and government-assistance measures that affect industry growth and farm performance improvements. It focused on some case-study communities to show the benefits of improving farm-management practices.

Overseas collaborating country

Pakistan

Commissioned organisation

D.N. Harris and Associates, Australia

Project leader

Mr David Harris
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Project budget

$150,000

Project duration

01/06/2007 to 30/09/2008

ACIAR Research Program Manager

Dr Jeff Davis

Project outcomes

A considerable amount of time and effort was invested in scoping a policy project focused on the smallholder dairy sector. The aim of the project was to review the economic and policy constraints holding back industry development. A key aspect of the project was to examine how policy interventions had shaped the development of dairy industries in other countries. Australia and India were nominated as the candidates for this purpose.

For various reasons, the project was unable to proceed. In developing the project, some preliminary research was undertaken on policy interventions and industry development in Australia. Project members therefore summarised what was learned from that exercise as a prelude to any future project development.

Bangladesh

12 Bangladesh chapter from the Annual Operational Plan 2009–10

12.1 Medium-term strategy

ACIAR's strategy in Bangladesh is to focus on agronomic and biotic constraints to the production of broadacre grain crops, either through bilateral projects or projects led by international agricultural research centres (IARCs). These projects link to existing programs such as the Consultative Group on International Agricultural Research coordinated Rice–Wheat Consortium and the International Rice Research Institute (IRRI)–International Maize and Wheat Improvement Center (CIMMYT-Mexico) Alliance for Intensive Production Systems in Asia. While in the past the emphasis has been on 'Rabi' or winter-season crops such as pulses, wheat and maize, the focus will shift increasingly to taking a farming-systems approach to underpin broader food-security issues. This will be achieved by expanding the work on rice-based farming systems and by broadening the scope of the program in Bangladesh to include a greater focus on food security and climate change adaptation.

12.2 Key performance indicators (2009–10)

- broadening of the Bangladesh program to include a suite of new linked activities aimed at increasing production of rice-based cropping systems, including climate adaptation work to safeguard future food security
- increased adoption of winter (Rabi) season cropping using residual soil moisture or supplementary irrigation in traditional rice-fallow regions.

12.3 Position

Bangladesh has been a partner country since the mid 1990s. ACIAR's program is comparatively small in view of Australia's limited comparative advantage to deal with Bangladesh's rice-dominated agricultural problems. Projects have focused on constraints to broadacre crop production (especially the rice–wheat system) and the potential for increased inclusion of a legume component in cropping systems. This past focus will broaden with the emergence of rice–maize as an increasingly important cropping system. However, it is recognised that the national focus on rice can compromise nutrition and, as such, work on improved pulse productivity and availability will continue.

With re-emerging concerns about Bangladesh's ability to maintain food security in the light of its high vulnerability to the impacts of climate change, the emphasis will shift to increasing the productivity of rice as the main staple. Low-lying areas and rainfed cropping systems in Bangladesh are particularly impacted by the effects of seasonal climate variability and impacts of climate change. Consequently, Bangladesh will be one of four partner countries involved in ACIAR's climate change adaptation initiative designed for implementation during 2009.

12.4 Research priorities

Priorities for collaboration are developed through meetings of ACIAR research program managers and other senior staff with managers and scientists at agricultural research and development institutions and government bodies in Bangladesh. Current collaboration is mainly in the production and management of grain crops. In the medium term, ACIAR will consider projects in the area of agronomic and biotic

constraints to the production of broadacre grain crops, and will consult more extensively with Bangladesh partners during 2009–10 on priorities for climate change adaptation research with impact at the farm level.

13 Active projects in Bangladesh

Project number	*Project title*
CIM/2003/067 (multilateral)	Ensuring productivity and food security through sustainable control of yellow rust of wheat in Asia (CIMMYT)
CIM/2007/122 (multilateral)	Sustainable intensification of rice–maize production systems in Bangladesh (IRRI)
LWR/2005/001	Addressing constraints to pulses in cereal-based cropping systems, with particular reference to poverty alleviation in north-western Bangladesh
LWR/2005/146	Expanding the area for Rabi-season cropping in southern Bangladesh
LWR/2008/015	Developing options to mainstream climate adaptation into farming systems in Cambodia, Lao PDR, Bangladesh and India

CIM/2003/067: Ensuring productivity and food security through sustainable control of yellow rust of wheat in Asia

Losses of wheat crops from cereal rust diseases are a major threat to food security. Yellow rust (*Puccinia striiformis* f. sp. *tritici* or Pst) affects wheat in most conditions and is therefore a major threat throughout Asia. Yellow rust's causal agent (Pst) is capable of rapid evolution into new wheat races and of migrating long distances on the wind. Host-plant resistance is the main control, but breakdowns of resistance in China, Pakistan and elsewhere in central and western Asia have recently occurred. Resistant gene isolines will be used to monitor Pst virulence in Asia as an early warning system against further outbreaks. These isolines will also be used to help identify resistance genes for introduction into new cultivars.

Overseas collaborating countries

Afghanistan, Bangladesh, China, India, Pakistan

Commissioned organisation

International Maize and Wheat Improvement Center (CIMMYT), Mexico

Project leader

Dr Ravi Singh
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Collaborating institutions

University of Sydney, Australia
International Center for Agricultural Research in the Dry Areas, Syria
Global overseas collaborators

Project budget

$1,000,050

Project duration

01/01/2005 to 31/12/2009

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2003/067>

CIM/2007/122: Sustainable intensification of rice–maize production systems in Bangladesh

In Bangladesh, the rise in demand for maize—as human food and from the poultry and fish industries—has led to a trend away from traditional rice–rice and rice–wheat cropping systems and toward rice–maize systems. But actual farm yields of rice and maize fall below their potential. This project will identify, test and promote key interventions in four districts that will lead to sustainable cropping intensification—resulting in double- and/or triple-cropping rice–maize systems. Specific objectives to improve these systems are to: 1. assess and prioritise constraints to, and opportunities for, uptake of improved management options; 2. evaluate and identify elite maize germplasm tolerant of excess moisture; 3. develop locally adapted management solutions for high-yielding, profitable, resource-efficient and sustainable rice–maize systems; and 4. build capacity and disseminate key technologies. Associated socioeconomic studies will undertake a strategic assessment and an empirical analysis of rice–maize systems and also conduct an impact assessment of key rice–maize options for the intensification of rice-based cropping systems.

The project will be jointly managed by IRRI and CIMMYT in collaboration with government organisations (Bangladesh Agricultural Research Institute, Bangladesh Rice Research Institute, Bangladesh Academy for Rural Development) and NGOs (BRAC, Rangpur Dinajpur Rural Service). We will establish partnerships using a range of public- and private-sector extension mechanisms to achieve rapid out-scaling of adapted management practices, thereby enabling large numbers of farmers to achieve high and sustained profit by adjusting the production of rice, maize, and other crops in response to markets and cost of inputs. We aim to achieve greater focus of partner institutions on sustainable system-level management, greater integration of germplasm improvement with crop management, greater consistency among researchers and between the public and private sector on technologies, and greater access of farmers to new information and technologies.

A technical expert group composed of lead investigators from government organisations and NGOs will facilitate consistency in the development and adaptation of technologies that address systems management. A national working group—which will additionally include representatives from extension, Bangladesh Agricultural Development Corporation, private seed companies, and local service providers—will facilitate wide-scale dissemination. The project builds on existing linkages and experience from IRRI, CIMMYT and ACIAR projects in Bangladesh and South Asia. It will link with two ACIAR projects—LWR/2005/001 (*Addressing legume constraints in cereals-based cropping systems*) and CIM/2007/027 (*Development of conservation farming implements*)—by adapting and using the zero- or strip-till drill and other machinery in those projects.

The project will have significant scientific, economic, social, and community impacts. Assuming that improved technologies are taken up over the duration of the project in 4% of current rice–maize areas, benefit will be A$22.8 million. If, after 5 years from project completion, the area of rice–maize remains unchanged but adoption of technologies increases to 10% of the area, the benefit will be A$113 million. Capacity of researchers, extension workers, and farmers will be enhanced with regard to new technologies for system management. The adoption of sustainable intensive rice–maize systems will generate more year-round on-farm employment for the rural workforce.

Overseas collaborating country

Bangladesh

Commissioned organisation

International Rice Research Institute, Philippines

Project leader

Dr Jagadish Timsina
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Collaborating institutions

International Rice Research Institute, Philippines
Bangladesh Agricultural Research Institute, Bangladesh
Bangladesh Rice Research Institute, Bangladesh
Rangpur Dinajpur Rural Service, Bangladesh
Bangladesh Academy for Rural Development, Bangladesh
Bangladesh Rural Advancement Committee, Bangladesh
International Maize and Wheat Improvement Center, Mexico

Project budget

$1,800,000

Project duration

01/07/2008 to 30/06/2013

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2007/122>

LWR/2005/001: Addressing constraints to pulses in cereals-based cropping systems, with particular reference to poverty alleviation in north-western Bangladesh

North-western Bangladesh, the poorest region of the country, with regular food shortages and dietary imbalances, grows few pulse crops such as chickpea, lentil, mung bean and black gram. This project will institute a targeted program to increase the production of chickpea and lentils in districts of north-western Bangladesh—to enhance income generation, improve human health and contribute to cropping system sustainability. It will build on work of recent projects in the target area, carrying forward applied research and on-farm evaluation as required but focusing on achieving early impacts through dissemination of information to resource-poor farmers. Successful implementation of the project will substantially increase income of participating households.

Overseas collaborating country

Bangladesh

Commissioned organisation

Murdoch University, Australia

Project leader

Associate Professor Richard Bell
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Collaborating institutions

Bangladesh Agricultural Research Institute, Bangladesh
International Maize and Wheat Improvement Center, Bangladesh
People's Research Oriented Voluntary Association, Bangladesh
Rangpur Dinajpur Rural Service, Bangladesh
Bangladesh Agricultural Research Council, Bangladesh
Department of Agriculture and Food, Western Australia, Australia
Department of Agricultural Extension, Bangladesh
PROSHIKA, Bangladesh
International Center for Agricultural Research in the Dry Areas, Syria

Project budget

$1,141,580

Project duration

01/10/2006 to 30/09/2010

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2005/001>

LWR/2005/146: Expanding the area for Rabi-season cropping in southern Bangladesh

Farmers in southern Bangladesh currently depend primarily on one wet-season rice crop per annum to provide income for their families, meaning that around 800,000 hectares lie uncultivated during the dry (Rabi) season. This is primarily because irrigation resources are limited, but other constraints also add to the perception that the area is too risky for wheat in a rice–wheat rotation. This project builds on earlier research funded by ACIAR and the Food and Agriculture Organization of the United Nations (FAO). Its major aim is to address the constraints of water and unsuitable management practices, thereby improving the livelihoods of these farmers by making their fallow lands productive during the post-rice Rabi season.

Overseas collaborating country

Bangladesh

Commissioned organisation

CSIRO Sustainable Ecosystems, Australia

Project leader

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Collaborating institutions

International Maize and Wheat Improvement Center, Bangladesh
Bangladesh Agricultural Research Institute, Bangladesh
PROSHIKA, Bangladesh
University of Queensland, Australia
International Rice Research Institute, Bangladesh
Forum for Regenerative Agriculture Movement, Bangladesh

Project budget

$1,082,100

Project duration

01/01/2007 to 30/06/2010

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2005/146>

LWR/2008/015: Developing options to mainstream climate adaptation into farming systems in Cambodia, Lao PDR, Bangladesh and India

Climate change impact is likely to be exacerbated where policy environments and capacity to respond are weak, and will amplify the current food-security crisis. This is the case in many Asian economies that heavily depend on agriculture. ACIAR plans to establish a dedicated climate change initiative, which is anticipated to proceed in two stages. Stage 1 will initially focus on farm-level adaptation research in India (particularly Andhra Pradesh state), Bangladesh, Cambodia and Laos, where there are considerable opportunities to build on past and ongoing ACIAR farming-systems projects. This small research activity will facilitate the scoping and design phase of Stage 1, leading into a 4.5-year program to commence in October 2009. The scoping team members will assess the constraints and opportunities to climate adaptation at the farm level in the four target countries. They will also assess, in the context of climate variability and climate change, the ability of selected farming systems modelling tools to adequately capture biophysical and socioeconomic dimensions of rice-based cropping and mixed crop–livestock systems prevalent in the target regions. Finally, they will develop benchmarking methods and data collection (survey) protocols, providing a framework to assess impacts of adaptation. It is anticipated that this framework will undergo further development and testing in selected countries as part of this study.

Overseas collaborating countries

Bangladesh, Cambodia, India, Lao PDR

Commissioned organisation

CSIRO Sustainable Ecosystems, Australia

Project leader

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Project budget

$299,824

Project duration

01/12/2008 to 30/09/2009

ACIAR Research Program Manager

Dr Mirko Stauffacher

Website

<www.aciar.gov.au/project/LWR/2008/015>

14 Projects expected to start in 2009–10

Project number	*Title*	*Countries*
ADP/2009/039	Policy linkages to food security work (Lao PDR, Cambodia, Bangladesh)	Bangladesh Cambodia Lao PDR
CIM/2009/038	Crop production in Bangladesh	Bangladesh
LWR/2008/019	Building capacity of farming communities in Cambodia, Lao PDR, Bangladesh and India to adapt to climate change	Bangladesh Cambodia India Lao PDR
LWR/2009/040	Climate change meta analysis	Bangladesh Cambodia China East Timor India Indonesia Lao PDR Pakistan Papua New Guinea Philippines Vietnam

15 Bangladesh chapter from the Annual Report 2008–09

15.1 Position

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

15.2 Achievements

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

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

North-western Bangladesh, the poorest region of the country with regular food shortages and dietary imbalances, grows few pulse crops such as chickpea, lentil, mung bean and black gram. A project is instituting a targeted program to increase the production of chickpea and lentils in this part of Bangladesh, to enhance income generation, improve human health and contribute to cropping-system sustainability. Experiments with chickpea to determine the optimum soil-moisture level for seedling establishment, effect of mulching with strip tillage, optimum seed and phosphorus rates

with strip tillage plus other factors were successfully conducted. In northern districts, yields from most of the 35 lentil demonstrations were around 1 tonne per hectare, with low yields attributable to excessive soil moisture and use of strip tillage.

The IRRI–CIMMYT joint project ‘Sustainable intensification of rice–maize production systems in Bangladesh’ started in November 2008.

16 Projects concluded in 2008–09

CSE/2007/027: Development of conservation farming implements for two-wheeler tractors (power-tillers) in Cambodia, Lao PDR and Bangladesh

In the last decade, mechanisation based on two-wheel tractors (power-tillers) has become widespread in parts of South and South-East Asia. The versatility of power-tillers offers significant opportunities to promote conservation tillage in areas of Asia that are transitioning into mechanised agriculture (e.g. Bangladesh, Burma, Cambodia and Laos). However, little work has been undertaken in systematic design, development and testing of implements for use with power-tillers, and there are problems with machinery standardisation between the different power-tiller manufacturers. This small research activity helped to develop a universal toolbar complete with a set of conservation farming attachments (including both full-tillage and zero-tillage seed drills) for use on a range of differently configured power-tillers. Research was also conducted to further modify the existing standard Asian rotary hoe full-tillage power-tiller seed drill, to convert it to a true zero-tillage/strip-tillage unit for operating in an extensive range of soil and environmental conditions.

Overseas collaborating countries

Bangladesh, Cambodia, Lao PDR

Commissioned organisation

Agricultural consultant, Australia

Project leader

Mr R.J. Esdaile
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Project budget

$46,500

Project duration

01/06/2007 to 31/03/2009

ACIAR Research Program Manager

Dr John Dixon

Project outcomes

Project work commenced with the importation of a 12-horsepower two-wheel tractor and a Chinese-developed 2BG-6A rotary-tillage seed drill. Seven seed drills were fabricated. Five drills are of the tine type on a toolbar frame, modelled on the original CIMMYT two-wheel tractor seed drill. The other two are modifications of the Chinese 2BG-6A rotary-tillage seed drill, which is now being sold in Asia.

Spring Ridge Engineering of Spring Ridge NSW, a north-western NSW agricultural implement manufacturer, has done much of the design and all of the fabrication. The project co-coordinator did some of the original design work.

The tined drills are structurally sounder and more versatile than the original CIMMYT units. They are based on a toolbar concept, fitted with seed and fertiliser boxes and have press wheels fitted. The seed-metering system is adjustable and capable of

handling practically all crop seeds from maize to mustard. Separate fertiliser placement is available as an option. Row spacing, frame layout, seed and fertiliser rate, and seeding depth are fully adjustable.

The rotary tillage drills have been modified to enable strip-tillage planting if required. These units have similar seed and fertiliser boxes to the tined implements and also are fully adjustable for row spacing and seeding depth. They also have press wheels fitted.

In September 2007, the first tined drill was shipped to Bangladesh. It was assembled in October 2007 (with the addition of some local parts) and has been used since then in north-western Bangladesh. A second tined drill and a rotary-tillage drill were shipped to Bangladesh in March 2008. One tined drill was sent to Cambodia in mid 2008, and another went to Laos at the same time.

Both implements are suitable for traditional or conservation farming systems. The seeders are simple, and light in weight. The tined drill can be adjusted for use as an inter-row cultivator, land leveller, bed shaper, or boom spray. Two Bangladeshi manufacturers fabricated local examples in late 2008 and have taken orders for more units.

Both the tined and rotary seed drills have been intensively tested in farmers' fields in north-western Bangladesh for most crops. They have proven to be successful and there has been considerable farmer interest. The tined units supplied to Cambodia and Laos are also being evaluated in these countries.

Two units (one each of the tined drill and the rotary tillage drill) remain in Australia. The tined drill was demonstrated to ACIAR staff and the media at the CSIRO Ginninderra Research Station in Canberra in January 2008.

The tined drill was subjected to comprehensive testing at the Agricultural Engineering Department of the University of Southern Queensland and was shown to be structurally capable of performing in the field as designed.

A promotional DVD and brochure for these implements have been produced, and a pamphlet on 'instructions for use' for each implement has been written.

Full details of these seed drills were presented to the Fourth World Congress on Conservation Agriculture in Delhi in February 2009, and there is moderate interest from nations where two-wheel tractors are extensively used.

Other South Asian and Middle Eastern countries:

Bhutan, Afghanistan and Iraq

17 Bhutan, Afghanistan and Iraq chapter from the Annual Operational Plan 2009–10

17.1 Medium-term strategy

ACIAR is managing one large project in Iraq, co-funded by AusAID. It is anticipated that support will be limited to this project in the medium term as Iraq passes through a critical period of consolidation, with recent improvements in its security environment. Activity in Iraq and Afghanistan will continue through collaboration with CGIAR centres. CIMMYT and ICRISAT are leading the activities in Afghanistan, while the International Centre for Agricultural Research in the Dry Areas (ICARDA) is the key partner in the ACIAR-supported project in Iraq. In Afghanistan and Iraq, there are complex operating environments resulting from poor security and political uncertainty that limit access by Australian scientists and hinder donor capacity for long-term planning.

In Bhutan, there is one major active project, and any additional projects would need to be initiated and strongly endorsed at an early stage by the Royal Government of Bhutan and closely fit Australia's skills and expertise.

Priorities are developed through visits by research program managers and other senior staff meeting with leading agricultural research and development institutions and government bodies. Efforts are also made to collaborate and coordinate with other implementing partners, including government, NGOs, grower and industry groups, and donor organisations.

17.2 Key performance indicators (2009–10)

- control measures for fruit fly and psyllid insect vector of citrus greening disease tested under commercial orchard conditions in Bhutan
- new maize varieties arising from ACIAR-managed research available to Afghani farmers
- conservation-cropping practices demonstrated to farmer groups in northern Iraq.

17.3 Bhutan

Because of Bhutan's relative lack of capacity to effect significant change across many agricultural sectors at once, the program will remain small and very tightly focused. Earlier ACIAR research to develop Newcastle disease vaccine for village chickens was extended and adapted for the situation in Bhutan with the help of AusAID funding, and projects were initiated on the management of fruit flies and on management of footrot in ruminants. A major initiative on improvement of citrus production (Bhutan's largest horticultural export industry) and pest and disease management is being implemented, and a smaller study on water and land management was carried out in 2008.

17.4 Afghanistan

Two decades of war coupled with a recent severe drought have devastated Afghanistan's food-production capabilities and depleted critical seed stocks, leaving the nation heavily dependent on food aid from international donors. ACIAR's collaboration with Afghanistan, which started in 2002, provides support to wheat and maize production. Wheat is by far the most important crop, while maize is the third most important. Activities have aimed principally to import seed from suitable cultivars,

establish on-farm participatory testing of imported germplasm for the identification of better-adapted improved cultivars, and undertake local multiplication and distribution of selected cultivars. Particular attention is being paid to capacity building, improving rust resistance in wheat (with specific attention to the new stem race variant designated Ug99) and promoting improved crop management, along with provision of improved cultivars of both wheat and maize. The gains made with cereal-based systems will be extended through a capacity-building initiative to assist Afghani counterparts to design and implement community-based watershed programs, and provide on-the-job training, external training courses and Master's degree (MSc) programs.

ACIAR is exploring future program options with the Ministry of Agriculture, Irrigation and Livestock, CGIAR partners and AusAID around capacity building in watershed management. Community-based watershed development provides an entry point for transfer of many improved agricultural technologies and for cropping diversification. This watershed focus will also strengthen on-farm engagement through the current project (CIM/2007/065) for cereals, further legume research linked to cereal-based systems, conservation agriculture, weed control, water-use efficiency of cropping systems, and higher value crops for sale to enhance farmers' livelihoods. ACIAR's project partners will work with in-country organisations who have established programs in agricultural extension and community development.

17.5 Iraq

Iraqi scientists have had limited access to international developments in the agricultural sector for over 2 decades. Consistent with other support provided by the Australian Government, the ACIAR-managed, AusAID-funded projects are intended to facilitate the development of modern and sustainable agricultural production and marketing systems in Iraq.

In Iraq, pressures to abandon cereal–fallow rotations exacerbated soil degradation and nutrient depletion to the extent that established cropping systems are in serious decline. The introduction of sustainable tillage will play a key role in restoring these systems and spillover benefits are also expected beyond Iraq. The project has been shaped by the relevance of Australian expertise to Iraqi conditions, but constrained by the inaccessibility of Iraq by Australian scientists. It focuses on the enhancement of barley, wheat and grain-legume production under dryland conditions in northern Iraq through the introduction and evaluation of appropriate modern varieties; and on the adaptation of improved management practices, including tillage, fertiliser and weed-control techniques. Achieving a sustainable increase in domestic production is now a national imperative.

Significant yield improvements are anticipated, given that current yields of these crops are only about one-third of those under similar conditions in developed countries. Iraq's agricultural sector represents a vital component of its economy as it is the largest employer (25% of the labour force) and the second-largest industry after oil (contribution to the gross domestic product; GDP). The 2-million-hectare central-southern irrigated zone that produces vegetables and fruit as well as cereals is under increased pressure from salinity. According to the FAO, it is estimated that approximately 75% of this region is moderately saline and another 25% has levels of salinity that prevent farming. Ineffective and poorly maintained irrigation infrastructure, compounded by increasing levels of salinity of the irrigation water from both the Euphrates and Tigris rivers due to changed water regimes, has led to the current situation. ACIAR's proposed project focuses on understanding salinisation processes, water management and the use of moderately saline soil for agricultural production. The project is funded by AusAID and managed by ACIAR, and executed by ICARDA and Australian research organisations.

18 Active projects in Bhutan, Afghanistan and Iraq

18.1 Subprogram 1: Field crop germplasm improvement and utilisation

Project number	*Project title*
CIM/2003/067 (multilateral)	Ensuring productivity and food security through sustainable control of yellow rust of wheat in Asia (CIMMYT)
CIM/2004/004 (multilateral)	Plant genetic resource conservation, documentation and utilisation in Central Asia and the Caucasus (ICARDA)
CIM/2007/065 (multilateral)	Sustainable wheat and maize production in Afghanistan (CIMMYT)
CIM/2008/027	Development of conservation cropping systems in the drylands of northern Iraq

CIM/2003/067: Ensuring productivity and food security through sustainable control of yellow rust of wheat in Asia

Losses of wheat crops from cereal rust diseases are a major threat to food security. Yellow rust (*Puccinia striiformis* f. sp. *tritici* or Pst) affects wheat in most conditions and is therefore a major threat throughout Asia. Yellow rust's causal agent (Pst) is capable of rapid evolution into new wheat races and of migrating long distances on the wind. Host-plant resistance is the main control, but breakdowns of resistance in China, Pakistan and elsewhere in central and western Asia have recently occurred. Resistant gene isolines will be used to monitor Pst virulence in Asia as an early warning system against further outbreaks. These isolines will also be used to help identify resistance genes for introduction into new cultivars.

Overseas collaborating countries

Afghanistan, Bangladesh, China, India, Pakistan

Commissioned organisation

International Maize and Wheat Improvement Center, Mexico

Project leader

Dr Ravi Singh
Phone: 52 55 5804 2004
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Email: r.singh@cgiar.org

Collaborating institutions

University of Sydney, Australia
International Center for Agricultural Research in the Dry Areas, Syria
Global overseas collaborators

Project budget

$1,000,050

Project duration

01/01/2005 to 31/12/2009

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2003/067>

CIM/2004/004: Plant genetic resource conservation, documentation and utilisation in Central Asia and the Caucasus

Crop production in Central Asia and the Caucasus (CAC) takes place under a range of environmental stresses that mirror many of those in Australia—for instance salinity, desertification, acidity, encroaching urbanisation and climatic changes. Both biotic (plant) and abiotic (soil) stresses and constraints create pressures on cropping varieties, and often cause rapid changes in the interactions between plants and their environment.

There is potential to address many of the factors threatening production in changing environments by tapping into the rich storehouse of agro-biodiversity found in cropping varieties in CAC. The region is both a centre of origin for many crop species and near relatives, and many varieties are adapted to a range of climates, environmental stresses and constraints. Maintaining the plant genetic resources (PGRs) of the CAC region is vital to realising this potential.

Since the break-up of the former Soviet Union in the 1990s, research capacity in the CAC has been significantly disadvantaged. An effective research and development sector is vital for boosting agricultural productivity and for conserving any genetic resources that may have a valuable role to play in achieving greater productivity. The establishment of sustainable national programs, covering collection through to preservation, has been achieved through a previous ACIAR–ICARDA project. Scientists need to build on the momentum of this work to ensure capacity in PGR conservation and other plant-related research becomes entrenched.

The project comprised the following objectives:

- consolidate the development of a long-term regional capacity to collect, conserve, document, utilise and exchange PGRs in accordance with their obligations as signatories to the International Treaty on Plant Genetic Resources for Food and Agriculture
- identify and assemble national base collections of seed for field-crop species
- consolidate the development of a comprehensive national and regional PGR information system that will allow: 1. PGR workers to collect, acquire, conserve and document national PGR collections more efficiently; and 2. plant breeders to more efficiently utilise PGRs from the region
- compile detailed information surfaces that characterise the environments from which PGRs have been collected in the CAC region
- collect and characterise material from under-represented agro-climatic-edaphic regions in CAC
- identify and screen subsets of accessions originating from the CAC region that have potential variation for limiting factors of importance to the CAC and Australian scientific communities
- disseminate information generated in this project to likely end users of PGRs, particularly in the CAC region and to the Australian scientific community.

Overseas collaborating countries

Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Syria, Tajikistan, Turkmenistan, Uzbekistan

Commissioned organisation

International Center for Agricultural Research in the Dry Areas, Syria

Project leader

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Collaborating institutions

Centre for Legumes in Mediterranean Agriculture, Australia
Australian Winter Cereals Collection, Australia
Research Institute of Genetic Resources, Azerbaijan
Georgian Research Institute for Crop Husbandry, Georgia
Armenian Botanic Institute, Armenia
Ministry of Agriculture, Kazakhstan
Research Institute of Crop Husbandry and Plant Industry, Kyrgyzstan
Tajik Academy of Agricultural Sciences, Tajikistan
Turkmen Research Institute of Cereals and Legumes, Turkmenistan
Uzbek Research Institute of Plant Industry, Uzbekistan
Department of Primary Industries, Victoria, Australia

Project budget

$543,996

Project duration

30/06/2004 to 31/12/2011
(Project extended from 01/07/2007 to 31/12/2011)

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2004/004>

CIM/2007/065: Sustainable wheat and maize production in Afghanistan

Wheat is the major grain crop in Afghanistan, grown in both irrigated and rainfed conditions. The main constraints to wheat production for small-scale farmers in Afghanistan are a lack of improved, adapted varieties, limited availability of quality seed, limited access to fertilisers, inadequate production technologies and damaged rural infrastructure. The Afghanistan Ministry of Agriculture, Irrigation and Livestock is committed to rebuilding agriculture in Afghanistan and has developed an Agriculture Master Plan which places a strong emphasis on cropping and capacity building. In line with that plan, this project will focus on continuing the introduction and screening of new wheat lines with a particular emphasis on resistance to yellow rust and stem rust (including Ug99), supporting the release of new high-yielding varieties, supporting the production and dissemination of quality breeder seed, enhancing targeting of wheat-improvement programs, evaluating and promoting crop-management practices, and ongoing capacity-building efforts.

Overseas collaborating country

Afghanistan

Commissioned organisation

International Maize and Wheat Improvement Center, Afghanistan

Project leader

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Project budget

$1,525,180

Project duration

01/10/2007 to 30/09/2011

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2007/065>

CIM/2008/027: Development of conservation cropping systems in the drylands of northern Iraq

Agricultural production in Iraq suffers from past mismanagement caused by civil instability with associated loss of capacity, plus the effects of periodic droughts. ACIAR and AusAID are funding assistance, and this project builds upon earlier work in CIM/2004/024 *Better crop germplasm and management for improved production of wheat, barley and pulse and forage legumes in Iraq*, which operated from 2005 to 2008 in Ninevah governorate in northern Iraq. The project aims to increase productivity, profitability and sustainability of crops in the drylands of this region through testing and promotion of conservation cropping technologies. The scientists will evaluate technologies such as zero tillage and stubble mulching, identify improved crop cultivars and encourage better crop management. The work will lead to wide adoption of conservation cropping systems by farmers, development of local village capacities to produce and market seed and zero-tillage machinery, and improved technical capacity by agricultural agencies to plan, implement and monitor research and development programs. The project team will invite agricultural researchers, extension officers and leading farmers from the neighbouring governorates of Dohuk, Sulaymaniyah and Erbil as well as the more southerly Najaf to engage with the project, thus improving their knowledge of conservation farming and opening up possibilities for implementing the technologies in those regions.

Overseas collaborating country

Iraq

Commissioned organisation

International Center for Agricultural Research in the Dry Areas, Syria

Project leader

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Project website

<http://www.icarda.org/ACIAR/Index.htm>

Collaborating institutions

University of Western Australia, Australia
Department of Agriculture and Food, Western Australia, Australia
University of Adelaide, Australia
Ministry of Agriculture, Iraq
Mosul University Agricultural College, Iraq
Directorate of Agriculture, Ninevah, Iraq
University of Mosul, Iraq
Directorate of Agriculture, Iraq

Project budget

$4,710,420

Project duration

01/07/2008 to 30/06/2011

ACIAR Research Program Manager

Dr Paul Fox

Website

<www.aciar.gov.au/project/CIM/2008/027>

18.2 Subprogram 2: Horticulture, including pest and disease management

Project number	*Project title*
HORT/2005/142	Improving mandarin production in Bhutan and Australia through the implementation of on-farm best management practices

HORT/2005/142: Improving mandarin production in Bhutan and Australia through the implementation of on-farm best management practices

Over the next 5 years, the Royal Government of Bhutan wishes to substantially increase the country's production of citrus (mainly mandarin). Currently, annual total production is 36,000 tonnes, but the ambition is to export 100,000 tonnes annually. So far there has been no real policy or strategy formulated to obtain this outcome. This project seeks to lift overall productivity of Bhutan's citrus on a sustainable basis and to improve the quality and yield of its present mandarin cultivar. In Australia, the project will expand work already underway on mandarin rootstock/scion compatibility, tree and crop management strategies, assessment of fruit quality characteristics and marketing opportunities.

Overseas collaborating country

Bhutan

Commissioned organisation

NSW Department of Industry and Investment, Australia

Project leader

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Collaborating institution

Department of Agriculture, Horticulture Division, Bhutan

Project budget

$780,647

Project duration

01/04/2007 to 31/03/2011

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<www.aciar.gov.au/project/HORT/2005/142>

19 Bhutan, Afghanistan and Iraq chapter from the Annual Report 2008–09

19.1 Bhutan

Position

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

Achievements

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

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

19.2 Afghanistan

Position

ACIAR's program in Afghanistan aims to help the country recover from 2 decades of conflict by boosting wheat and maize production. Both are important staple food crops. Activities have focused on linking with multilateral research centres to introduce improved varieties that are better adapted to local conditions, and to multiply and disseminate seed of these varieties. Capacity building with local scientists through visits to research centres outside Afghanistan are also undertaken.

Achievements

The work to bring sustainable wheat and maize production to Afghanistan continued. Yield trials and screening nurseries were planned, designed, prepared and conducted in collaboration with the Afghanistan Research Institute of Agriculture (ARIA). The

project is progressing steadily in four areas of collaborative work to: identify suitable varieties with high yield, good adaptation and superior disease resistance in Afghan farming systems; develop/adapt appropriate wheat and maize production technologies; build capacity; and multiply base seed of experimental varieties resistant to the Ug99 strain of wheat rust.

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

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

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

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

19.3 Iraq

Position

Iraq's period of isolation from the international community during the first half of this decade, coupled with high levels of input subsidies, guaranteed commodity prices, and free food distribution, created significant disincentives to innovation. This was compounded by Iraqi scientists having limited access to international developments for more than 2 decades. ACIAR has one active project, co-funded by AusAID, that aims to modernise the agriculture sector through enhancing production of cereal crops in dryland areas. This is achieved through partnership with the International Center for Agriculture in the Dry Areas (ICARDA), an international agricultural research centre based in Syria, to trial modern crop varieties and introduce improved management options for those crops.

Achievements

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

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

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

Iraqi farmers is approaching 500 hectares, with zero-tillage demonstrations established with 20 Iraqi farmers in the first year of the new project.

The immediate benefits of reduced tillage include: lowered costs; improved structure, fertility and water infiltration of the soil; and associated economic benefits on-farm. In the longer term, other countries have shown a reduction in dust pollution from reduced tillage, and also less smoke pollution as the burning of crop residues is reduced in association with zero-tillage practices. It is expected that these longer term benefits to human health will similarly follow in Iraq as the improved technology gains momentum.

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

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

Rebuilding agriculture in Afghanistan and Iraq

The wheat crop in Afghanistan falls short of demand by 1.5 million tonnes per annum. Looking for reasons, scientists from the Consultative Group for International Agricultural Research centres worked with the Afghan Ministry of Agriculture in the early 2000s. They found that farming infrastructure had collapsed and the country's agricultural biodiversity was in peril.

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

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

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

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

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

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

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

20 Impact Assessment Program

ACIAR has a long history of assessing the impact of its research and development (R&D) investments. These assessments have provided valuable lessons in improving the selection, design and delivery of R&D projects. They have also been useful for demonstrating the value of ACIAR as part of Australia's international development assistance program. The two main types of finished project assessments are adoption studies and impact assessments.

Adoption studies became part of ACIAR's evaluation strategy in 2003–04. They are undertaken by project leaders on completed projects where ACIAR expenditure was greater than $400,000, and for which there is no follow-on project. The primary purpose of these evaluations is to provide information on the uptake of the project results, three years after a project's completion. In addition, where there has been no adoption, information on the reasons for the lack of uptake is sought. Information from adoption studies, of which over 50 have been completed to date, is used to support ACIAR's investment decision-making process, in project development and design and in the selection of projects for impact assessment.

Impact assessments involve extensive analysis of the adoption and impact of the project results, both in the partner country or countries and in Australia. Over the last six years, there has been an increased focus on undertaking thematic impact assessments, rather than assessing the impact of individual projects. The credibility of ACIAR impact assessments has been enhanced by several meta evaluations and the use of independent consultants to undertake the studies. In addition, stratified random-sampling techniques are used, where practical, to select projects for impact assessments. ACIAR has also published guidelines for assessing the impacts of its research activities to ensure rigour and consistency in all future assessments.

As part of the evaluations, areas for practical methodology innovations were identified and some advances in impact assessment methods were made. In recent years, the focus has been on developing and implementing frameworks to measure the returns to ACIAR's investment in capacity building. Over 50 full benefit–cost assessments have been published in ACIAR's impact assessment series.

ACIAR has developed a database for systematically recording all the adoption studies and impact assessments and providing important summary information to support decision-making. This continues to be developed, expanded and refined to ensure maximum use is made of the results of these impact assessment efforts.

ACIAR has begun the process of linking its impact assessment work to the activities of the Australian Government's Office of Development Effectiveness and will strengthen this link during 2009–10.

20.1 Impact assessments undertaken in 2008–09

This year, five impact assessment studies were undertaken, with details reported below. The ACIAR Database for Impact Assessments became operational, with a report describing the framework and functionality of the database published in the Impact Assessment Series. The database allows a comprehensive update of previous analysis of returns to ACIAR's investments in R&D. Based on an analysis of the quantitative information obtained from 37 ACIAR impact assessment studies, the total cost of the investment in these projects is around $234 million in net present value terms (2008 dollar equivalents). Of these costs, $128 million are direct ACIAR costs. In total, these projects generated an estimated total benefit of $12.6 billion, with the benefits attributable to ACIAR being $6.8 billion. The benefit:cost ratio for all the projects evaluated is around 54:1.

This study also contained a significant qualitative element, which involved drawing evidence on the appropriateness, effectiveness and efficiency of ACIAR's activities within the broad context of Australia's aid delivery system. There is a particular emphasis on whole-of-government and public good issues, which demonstrates that ACIAR is an effective and efficient funding agency. Despite its relatively small size on the international aid and research for development arena, ACIAR performs well, ensuring that the research it invests in meets the needs of its stakeholders, makes a difference to the livelihoods of the poor and aligns within the broader Australian aid program.

Two-stage grain drying in the Philippines

Grain drying is a major issue in all grain-producing countries, presenting particular problems in humid, tropical climates. ACIAR and the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, in association with other Philippine research organisations, supported a major effort in this area dating back to the early days of ACIAR's activities. The assessment indicated that the grain-drying technologies had not been adopted in the Philippines despite evidence of adoption in other collaborating countries in the Asian region and in Australia. This lack of adoption and impact was due to the structure of the grain industry in the Philippines, with the grain-trading industry dominated by small-scale operators. As a consequence, economies of scale do not exist in grain trading, and the grain-drying technologies developed are therefore currently not profitable. These lessons will help guide future investments in research, in particular the interactions between local industry and policy conditions and research activities. The analysis undertaken suggests that, if the structure of the grain industry in the Philippines changes, application of the grain-drying technologies developed could yield returns as high as those gained in other countries.

ACIAR Database for Impact Assessments (ADIA): an outline of the database structure and a guide to its operation

This report describes the development of a database established as the repository of information from impact assessments. The database provides a mechanism to choose a stratified random sample of completed projects for impact assessment. As well, on the basis of the data entered, the database can be used to manipulate information and present it in various forms for reporting and analytical purposes.

Salinity reduction in tannery effluents in India and Australia

The tanning industry is an important contributor to economic output in India, particularly in the state of Tamil Nadu, which produces around 60% of India's total leather production. Tannery effluent, however, is high in salinity and has caused significant environmental damage, including increased salinity in groundwater and river systems, contaminating productive agricultural land and drinking water. Reducing the salinity of effluent was a common challenge for both Indian and Australian tanners. ACIAR provided funding of $0.8 million in nominal terms out of a total budget of $1.9 million for a project to reduce the salinity of tannery effluent by developing technologies that reduced salt inputs. The project was undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Textile and Fibre Technology in partnership with the Central Leather Research Institute in India. It is estimated that, in constant 2008–09 dollars, the project will deliver benefits to Indian tanners of around $62.0 million in present value terms, using a discount rate of 5%. Of these total benefits, $28.1 million can be attributed to ACIAR on a cost-share basis, resulting in a net benefit of $59.9 million; a benefit of $29.60 for every dollar spent. The internal rate of return on the project is estimated to be 35.1%.

Integrated management of insect pests of stored grain in the Philippines

Protecting stored grain in tropical areas relies on the use of pesticides. ACIAR supported a series of four research projects to develop effective alternative control options for major pests of stored grains in the tropical areas of Australia, the Philippines, Malaysia, Thailand and China. The combined research involved the Bureau of Postharvest Research and Extension and two research groups in Australia—the Queensland Department of Primary Industries and CSIRO. This assessment focused on the impact in the Philippines and, through surveys of members of the grain sector, found that there has been significant adoption of the outcomes. This has been primarily by the larger storage and handling sectors of the rice and other grain industries. The study found that the return on this significant investment by all parties was substantial, with a net present value of research gains to the Philippines of $1,696 million. This provides a benefit:cost ratio of approximately 174:1 and an internal rate of return of 46.6%.

Analysis of ACIAR's returns on investment: appropriateness, efficiency and effectiveness

Following the development of an impact assessment database, a study was commissioned to analyse the results of 37 quantitative impact assessments. In total, the benefits to ACIAR research calculated in these impact assessments are estimated at $12.6 billion for a total investment of approximately $234 million in 2008 dollar present value terms. Of the total benefits, $11.4 billion accrued to developing countries, with $1.2 billion in benefits to Australia. The average benefit:cost ratio across all assessed projects is 54. Of the $12.6 billion, the benefits directly attributable to ACIAR funding are estimated at $6.8 billion for an investment of $128 million across the assessed projects. Given that total ACIAR expenditure since inception is estimated at $2.1 billion, the returns from assessed research effectively pay for total expenditure more than three times over.

This impact assessment demonstrates the appropriateness, effectiveness and efficiency of ACIAR-funded research over a long period of time. A key finding is the importance of partner-country scientific, research and extension capacity. ACIAR's research tends to be more successful in countries with strong capacity in these areas, while countries where uptake of ACIAR research has been low tend to have lesser in-country capacity. Alignment of priorities agreed by partner countries and ACIAR is also an important factor in uptake of research.

20.2 Impact assessments planned for 2009–10

Key performance indicators

- at least five impact assessment studies of completed projects published
- impact assessment review of at least one thematic area in Indonesia
- impact assessment of at least one thematic area in Papua New Guinea (PNG)
- assessment of the impact of international agricultural research centre (IARC) activities in ACIAR's mandate region
- 2009–10 project leader adoption studies published for selected projects completed in 2005–06

- links established with partner-country, IARC and Australian impact assessment groups.

Key priorities

Project-specific

- Publish five assessments in 2009–10 of the impacts of completed projects (this year, with an emphasis on increasing the number of impact assessments undertaken in ACIAR's two largest partner countries, Indonesia and PNG)
- Where possible and appropriate, increase emphasis on the type and quantity of data used in the impact assessments, in an effort to further strengthen their rigour and credibility
- Review and publish the 2009–10 project leader adoption studies for the set of large projects concluded in 2005–06.

Capacity building

- Develop collaboration with Consultative Group on International Agricultural Research (CGIAR) centres in impact assessment activities, particularly of projects jointly funded through ACIAR
- Provide feedback on the implications of impact assessment studies for research project development and management within ACIAR, through 'lessons learnt' style meetings with all staff
- Enhance clarification and estimation of the outcomes of new projects, by assisting project research groups during peer review of their proposals and by including impact analysis in the project design; in particular, provide summaries of the implications of impact studies to meetings of these groups.

Thematic studies

- Review the application and impact of ACIAR natural resource management research activities in the Philippines
- Undertake an assessment of ACIAR's animal health and/or forestry research in Indonesia
- Commission a comprehensive review of all ACIAR impact assessment studies. This will expand its focus to include issues such as the public good basis for funding this type of collaborative research. It will also disaggregate the benefits to more accurately identify those attributed to other funders of the research and, especially, the development; and will look particularly for whole-of-government and between-government interactions; for example, the shares of benefits to other aid donors such as the Australian Agency for International Development (AusAID)

- Commission two studies to assess the impact of IARC activities in ACIAR's mandate region–-the first, review of past CGIAR impact assessment studies and development of an overview of the impact on the Asia–Pacific region and individual countries within this region; and the second, an assessment of the impact of at least one centre's genetic improvement program in ACIAR's mandate countries
- Work closely with the Office of Development Effectiveness (ODE) to ensure ACIAR's impact assessment work maintains close links with the ODE's activities.

21 Appendix 1: ACIAR contacts

21.1 Country Office

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22 Appendix 2: ACIAR publications

This is a list of ACIAR publications produced in 2008–09. Print copies are available by emailing <comms@aciar.gov.au>, or electronic versions may be downloaded from ACIAR's website <www.aciar.gov.au>.

Monographs	
120c	*Better-practice approaches for culture-based fisheries development in Asia* [Tamil translation], Sena S. De Silva, Upali S. Amarasinghe and Thuy T.T. Nguyen (eds), 2009, 117 pp.
120d	*Better-practice approaches for culture-based fisheries development in Asia* [Sinhalese translation], Sena S. De Silva, Upali S. Amarasinghe and Thuy T.T. Nguyen (eds), 2009, 115 pp.
129a	*Diagnostic manual for plant diseases caused by fungi and fungal-like pathogens* [Vietnamese translation], Lester W. Burgess, Timothy E. Knight, Len Tesoriero and Phan Thuy Hien, 2009, 210 pp.
134	*Growing peanuts in Papua New Guinea: a best management practice manual*, Michael Hughes, Rao C.N. Rachaputi, Lastus Kuniata and A. Ramakrishna, 2008, 77 pp.
135	*Sea cucumber fisheries: a manager's toolbox*, K. Friedman, S. Purcell, J. Bell and C. Hair, 2008, 34 pp.
136	*Measuring plant-associated nitrogen fixation in agricultural systems: theory and practice*, Murray Unkovich, David Herridge, Mark Peoples, Georg Cadisch, Bob Boddey, Ken Giller, Gruno Alves and Phillip Chalk, 2008, 258 pp.
137	*Jorani and the green vegetable bugs* [in English], Bob Martin and Deb White, 2009, 48 pp.
137a	*Jorani and the green vegetable bugs* [Khmer translation], Bob Martin and Deb White, 2009, 48 pp.
138	*Landcare in the Philippines: a practical guide to getting it started and keeping it going*, Landcare Foundation of the Philippines, Inc., 2009, 144 pp.

Proceedings	
128	*Management of classical swine fever and foot-and-mouth disease in Lao PDR*, J.V. Conlan, S.D. Blacksell, C.J. Morrissy and A. Colling (eds), 2008, 100 pp.
129	*Silvicultural management of bamboo in the Philippines and Australia for shoots and timber*, David J. Midmore (ed.), 139 pp.
130	*Efficient nutrient use in rice production in Vietnam achieved using inoculant biofertilisers*, I.R. Kennedy, A.T.M.A. Chudhury, M.L. Kecskés and M. Rose (eds), 2008, 136 pp.

Impact Assessment Series Reports	
59	*Two-stage grain drying in the Philippines,* Agnes Chupungco, Elvira Dumayas and John Mullen, 2008, 50 pp.
60	*ACIAR Database for Impact Assessments (ADIA): an outline of the database structure and a guide to its operation*, Centre for International Economics, 2009, 38 pp.
61	*Salinity reduction in tannery effluents in India and Australia*, Hayden Fisher and David Pearce, 2009, 53 pp.
62	*Integrated management of insect pests of stored grain in the Philippines*, S.R. Francisco, M.C. Mangabat, A.B. Mataia, M.A. Acda, C.V. Kagaoan, J.P. Laguna, M. Ramos, K.A. Garabiag, F.L. Paguia and J.D. Mullen, 2009, 45 pp.
63	*Analysis of ACIAR's returns on investment: appropriateness, efficiency and effectiveness*, Matthew Harding, Tingsong Jiang and David Pearce, 2009, 37 pp.

Final reports	
2008-19a	*Development of an embryo culture manual and an embryo transplantation technique for coconut germplasm movement and seedling production of elite coconut types [HORT/2006/006]* [Vietnamese translation], Stephen W. Adkins, Erlinda Rillo and Osmundo Orense, 2008, 29 pp. <http://www.aciar.gov.au/publication/FR2008-19a>
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