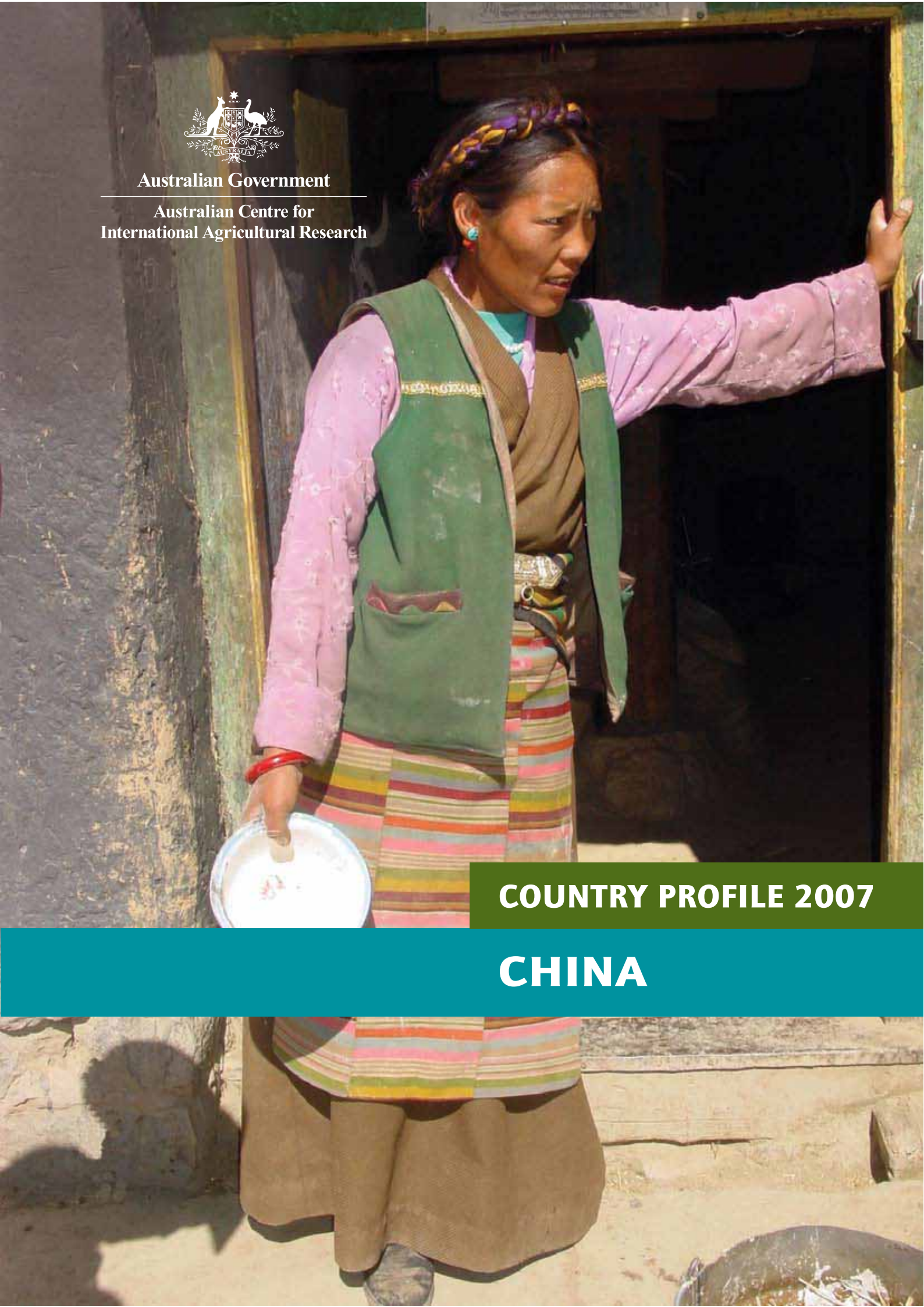

Australian Government

Australian Centre for International Agricultural Research

COUNTRY PROFILE 2007

CHINA

Australian Government

Australian Centre for
International Agricultural Research

COUNTRY PROFILE 2007

CHINA

The Australian Centre for International Agricultural Research (ACIAR) operates as part of Australia's international development cooperation program, with a mission to achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia. ACIAR commissions collaborative research between Australian and developing country researchers in areas where Australia has special research competence. It also administers Australia's contribution to the International Agricultural Research Centres.

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Contents

1 Preface

The ACIAR Country Profiles are designed to give a snapshot of the collaborative research being carried out between Australia and our various partner countries. This publication contains short summaries of bilateral and multilateral projects with China that were active from 1 July 2006 to 30 June 2007. At that time there were 18 active bilateral projects, and three active multilateral projects, the latter being led by international agricultural research centres. There were another 10 projects under development, many of which are expected to start in 2007–08 financial year.

This publication also sets out the key outputs and outcomes from 11 bilateral projects that have been completed between 1 July 2006 and 30 June 2007.

In addition to these project summaries, the publication includes an extract from ACIAR's 2006–07 Annual Report covering China, our near-term program as outlined in the 2007–08 Annual Operational Plan, and a summary of ACIAR's training program.

ACIAR updates this profile each year and distributes it to key stakeholders in China and Australia.

We hope you find the publication useful as a record of the progress and achievements between China and Australia. For information on ACIAR's overall program, we invite you to visit our website at www.aciar.gov.au.

Peter Core
Chief Executive Officer
November 2007

Catriona Murray
ACIAR Country Manager, China

2 Overview

2.1 ACIAR

The Australian Centre for International Agricultural Research (ACIAR) is an Australian Government Statutory Authority that operates within the portfolio of Foreign Affairs and Trade. It was established in June 1982 under the ACIAR Act to assist and encourage Australia's agricultural scientists to use their skills for the benefit of developing countries, and at the same time work to resolve Australia's own agricultural problems.

ACIAR's aims to enhance rural household incomes and broader economic growth by investing in international research partnerships that encourage agricultural development, sustainable use of natural resources and capacity-building of benefit to partner countries and Australia.

Research funded by ACIAR is mutually beneficial to Australian and developing country rural industries by harnessing Australia's outstanding strengths in agricultural research to develop partnerships with developing country research institutions.

ACIAR is based in Canberra, with offices in China, India, Indonesia, Papua New Guinea, the Philippines, Thailand and Vietnam.

Australia is in a particularly strong position to provide such assistance because it has a broad range of climates – cool and warm temperate, subtropical and tropical – that are typical of the developing world. Australia's scientists work within a very strong network of institutions, such as the CSIRO, Federal and state government organisations and universities.

The Australian Centre for International Agricultural Research (ACIAR) carries out research in the Asia-Pacific region, and currently has projects in the following regions:

- South-East Asia (Vietnam, Cambodia, Laos, Thailand, Indonesia, Philippines: >45% bilateral expenditure)
- Papua New Guinea and the Pacific islands (>20% of bilateral expenditure).
- North Asia (China: <15% of bilateral expenditure)
- South Asia (India, Pakistan, Bangladesh, Bhutan, Afghanistan, Iraq: <15% of bilateral expenditure)

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 CG engagement in the Asia-Pacific and to commission projects that are consistent with ACIAR's country program strategies.

2.2 Country Portfolio

ACIAR has supported a program of collaborative agricultural research with China since 1984. Most of the program consists of bilateral projects, in which an Australian research organisation is commissioned to undertake a specified research activity in collaboration with a partner organisation in China. China is also targeted in ACIAR's multilateral program delivered in conjunction with the international agricultural research centres.

ACIAR's program with China as at 30 June 2007.

Bilateral Program

Active projects	20 with a value over their lifetime of approximately $16,047,461.
Projects under development	10
Share of North Asia program	$2,867,548 which represents 100.0% of the total 2006–2007 North Asia program.
Completed projects	104

Multilateral Program

Active projects	2 with a value over their lifetime of approximately $721,037
Projects under development	1
Completed projects	14

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3.3 Policy Advisory Council member

The ACIAR Policy Advisory Council is established under the Australian Centre for International Agricultural Research Act 1982. Members are appointed by the Minister for Foreign Affairs, and represent ACIAR's key stakeholders or the implementing agencies for ACIAR's program in partner countries and Australia. Council members are drawn from government departments, research providers and industry, and are therefore well placed to advise on their respective countries' development and agricultural priorities and research needs.

The current member from China is Mr Jia Jingdun, Deputy Director General, Department of Rural and Social Development in the Ministry of Science and Technology (MOST). Mr Jia has been a member of the Council since March 2003.

4 Training

The ACIAR training program has a budget in 2007–08 of approximately $5.57 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 ($0.70 million) and sponsorship of attendees at Master classes 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 $4.53 million (this figure includes $3 million from AusAID) of the training program budget in 2007–08. The objective of the Scheme is to increase the research and development capacity of ACIAR partner country institutions. It provides funding for promising overseas researchers associated with ACIAR projects to undertake postgraduate studies in tertiary institutions in Australia.

John Allwright Fellowship Statistics

		PhD	MSc/Other
Active	Male	0	0
	Female	1	0
Concluded	Male	9	3
	Female	4	1

5 Annual Report 2006-07

Active projects in 2006-07	31
AOP budgeted expenditure in 2006-07	$3,225,574
Actual expenditure in 2006-07	$2,876,548
Expenditure in 2005-06	$3,733,227
Expenditure in 2004-05	$3,926,454

Key performance indicators	Performance 2006-07
Significant co-investment by Chinese partners in all new projects	All new Chinese projects incorporate Chinese funding and in kind contributions.
Medium-term strategy for program in Tibet Autonomous Region developed and agreed between ACIAR and Chinese counterparts	Medium-term strategy for the Tibet Autonomous Region has been developed, which will focus on the development of the crop-forage-livestock systems in the valley regions.
Communication of results of analysis of technical barriers affecting trade communicated to Chinese policymakers	Multilateral project addressing technical barriers affecting trade of China, the methodology and empirical applications have been presented to policy makers through published papers and international conferences.
Evidence of integration of biophysical and policy considerations in development of grassland management strategies	Framework developed including a feed balance analyzer and a biophysical / economic analysis using data on quantity and quality of forage sources, enterprise budgets and linear programming to identify the optimal combination of resources for alternative farm strategies. Field work detected further development of livestock markets and improving price signals for farmers.
40 per cent of new projects designed to have significant farmer or policy-maker impacts within five years of completion	Only one new standard project commenced in 2006/07 and it was deemed as likely to impact in 5-10 years. Three Small Research Activities commenced and two of these should have significant community impacts within 5 years.

5.1 Position

ACIAR has had a program with China since 1984. Major areas of research have included agricultural water management, selection of Australian trees suited to Chinese forestry, improvement and integrated pest management in brassica crops, studies of livestock production and diseases with a focus on sheep and wool, quality management in stored grains as well as broadacre crop and citrus improvement. Adoption of conservation tillage in some central western provinces has been recognised as part of the solution to improve crop management and reduce windblown dust in Beijing. In 1999, the focus of ACIAR's program shifted towards western China, in line with the need to raise farmers' incomes in this part of China and to better manage land and water resources.

In view of the significant human and financial resources available within the Chinese National Agricultural Research System and the strong mutual benefits to Australia, ACIAR requires that projects in China have significant sharing of costs by Chinese and Australian research providers. In many cases, ACIAR will seek a funding commitment through case-by-case exchanges of letters at the stage of development of full project proposals. Only a small proportion of the highest priority projects can be supported.

Projects chosen must:

- address the highest priority of Chinese partners
- address overall Australia–China development policy (to 'Further mutual interest by supporting China's balanced development policies and working together in the region')
- complement other schemes for China–Australia collaboration, including the AusAID Australia–China Environment Development program, to commence in 2006
- be in areas where the overwhelming driver is Australian technical comparative advantage
- complement rather than duplicate activities of other (larger) donors.

Within our stated priority areas, ACIAR will also fund small investments that foster collaborative linkages between activities that have been primarily funded from Australian and Chinese sources. ACIAR projects form only one part of the China–Australia inter-governmental cooperation in agriculture and natural resource management. Some information on the other programs, several of which provide financial support for collaboration between Chinese and Australian agricultural researchers, follows. Most of these programs operate through annual calls for applications.

- Department of Agriculture, Fisheries and Forestry (DAFF) in Australia and the Chinese Ministry of Agriculture jointly administer the **Australia–China Agricultural Cooperation Agreement** (ACACA, www.affa.gov.au/acaca), which provides funding for agriculturally oriented exchange projects between Australia and China. Projects from researchers, businesses, industry associations and farmers that help develop trading relationships, enhance cooperation in a wide range of agricultural sectors, provide a forum for the exchange of scientific information and, especially, encourage commercial linkages are encouraged. The focus of the present program is on projects that demonstrate potential for commercial outcomes and provide clear flow-on benefits to industry. Over 175 projects have been completed since 1984.
- Australian Government Department of Education Science and Training (DEST), 'International Science Linkages program' (www.dest.gov.au/science/isl) includes competitive grants under the **Australia–China Special Fund for S&T Cooperation**, in which agriculture, biotechnology and environmental research form three of the priority areas. The Australian Government through DEST has also provided funding to support a new Australia–China Centre on Water Resources Research. The centre will increase research networks between Australian and Chinese scientists and promote multidisciplinary research collaboration into water resources in both countries. Finally, the first exchanges under the DEST-managed Australia–China Young Scientist Exchange Program will commence during 2006–07.
- In addition **DEST** supports international exchanges, targeted scientific and technological individual visits, missions and workshops to promote scientific and technological collaboration. These are managed by the Australian Academy of Science (www.science.org.au/internat/index.htm) and the Australian Academy of Technological Sciences and Engineering (www.atse.org.au).
- Food Standards Australia and New Zealand and the Chinese Ministry of Science and Technology recently entered into a Memorandum of Understanding on **Scientific and Technological Cooperation in Food Safety**.
- The **Joint Declaration on Bilateral Cooperation on Climate Change** between the Australian Greenhouse Office (Department of Environment and Heritage, DEH) and the National Development and Reform Commission for China (www.deh.gov.au/minister/env/2003/mr24oct203.html) sets out cooperation in technology development and policy. During 2006, DEH will release the 'Australia–China Climate Change and Agriculture Research Prospectus' and fund several projects, of which at least one will be co-funding of a project managed by ACIAR.

From the Chinese side, the **State Bureau of Foreign Experts Affairs of China** is responsible for accrediting international educators in China and for identifying and negotiating training opportunities across the world that will be of benefit to China. The related China Association for International Exchange of Personnel (www.china.org.cn) is a government-sponsored institution also engaged in the international exchange of specialised technical and managerial personnel in several areas, including agriculture, science and technology.

5.2 Achievements

ACIAR projects in China are grouped under the following major themes:

- sustainable agriculture in north-western China
- improved agricultural productivity in Tibet Autonomous Region
- implications of Chinese trade developments for smallholders
- China linkages scheme.

China's western grasslands support the livelihoods of 40 million people, many from ethnic minorities. Income levels are amongst the lowest of any Chinese farmers. Grasslands are heavily degraded due to overgrazing, and have led to frequent dust storms, siltation of the Yellow River and declining biodiversity. A project aims to help **rehabilitate the grasslands** and improve smallholder incomes. Initially a model of the farming system is being developed, to evaluate technical and policy options to improve system sustainability.

A Stage 1 model aims to create a realistic picture of what is occurring on the farms, while a Stage 2 model is designed to identify the optimal combination of resources for alternative farm strategies. Using this framework the project team is ranking the choices available for research and farm improvement. The Stage 1 and Stage 2 models are now considered robust, and have become teaching tools for Chinese colleagues. The team is now working on the Stage 3 model, looking at the sustainability of the farm systems over a longer term, with emphasis on general relationships to estimate dust storm likelihoods and grassland stability in relation to the grazing pressure.

China and India are keen to **replace traditional rapeseed and mustard cultivars** with canola quality types (containing low levels of erucic acid and glucosinolate). They value Australia's canola quality *Brassica 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. A project seeking to develop *B. napus* (rapeseed) and *B. juncea* (Indian mustard) germplasm with improved canola quality, disease resistance (to *Sclerotinia*—white rust) and improved drought tolerance has screened germplasm to reveal some key characters that will be beneficial to the breeding of improved lines for each country. The project team has found white rust resistance in Australian and Chinese *B. juncea* lines, low erucic acid and low glucosinolate levels in Chinese and Australian *B. napus* and *B. juncea* lines, and drought tolerance in Australian *B. juncea* lines.

A project designed to develop **varieties of lucerne** with high levels of tolerance to adverse factors such as salinity, acid/aluminium soils, waterlogging or drought now has produced advanced lines with aluminium resistance. Aluminium screening has continued through several generations, and each successive generation has shown increased tolerance over the previous generation.

Further selections are continuing with the aim of releasing a cultivar in 2007. The evaluation of the material in pot experiments with acid soil has continued as well as field trials of the early acid-tolerant progeny. The acid/aluminium screening method has been adapted to screen both plants and rhizobia for nodulation at low pH. This is an important advance as acid-tolerant rhizobia are important for the success of lucerne in acid soils.

The Hexi Corridor, a distinct valley in Gansu in north-western China, relies on snowmelt for much of its water. Recent reduction in snow fall has seen farmers and others turn to available surface water, which is lowering recharge and at the same time lowering the watertable. Local policymakers have implemented water restrictions, rationing allocations and increasing water and pumping costs. This is adding to the number of other pressures already faced—high input costs, low mechanisation and low incomes—particularly by smallholders.

A project is encouraging **the adoption of permanent raised cropping beds** for wheat–maize rotations, including adapting existing tractors and improving agronomic and water management, to help alleviate many of these issues. The Gansu Agricultural Mechanisation Bureau (GAMB) has established the first of three demonstration sites to compare permanent raised beds, zero-till and conventional farming practices. A related project is underpinning the work by helping to develop criteria for **optimising bed design**, using analytical and numerical modelling of water and solute transport, designing placement strategies to maximise fertiliser usage and minimise leaching to groundwater; and determining the conditions most likely to lead to salinisation.

In the Tibet Autonomous Region the activities of small mammals, particularly the plateau pika, have degraded up to 15% of the region's valuable grassland ecosystems. Livestock numbers on the plateau have more than doubled in the past 50 years, but livestock carcass weight has declined in this time, suggesting that the system has been pushed so that animal productivity is declining. At the same time plateau pika numbers have increased, due to some factor in the system that has changed to their benefit.

A project has sought the reasons for the increase, postulating either a change in pasture composition and/or structure or improved burrowing conditions due to increased erosion. Recommended control techniques for the pika include a reduction in livestock density to prevent the system degrading further and moving to the highly degraded 'black soil' state.

In a project aimed at **intensifying production of grain and fodder in central Tibet** farming systems, excellent progress has been made in developing baseline information on Tibetan agriculture. The project team conducted interviews in 45 different farming households across central Tibet's cropping zone, exploring demographics, farm resources, the components of cropping and livestock enterprises, and associated inputs and outputs. Attitudes to fodder production and system change were also assessed. These results have provided a more accurate picture of the typical Tibetan farm, which is assisting the project's ongoing research work and providing a foundation for future efforts in extension.

In related work an Australian Youth Ambassador for Development has **described soils at key experimental sites**. Soil samples from farmers' fields across central Tibet were sent for nutrient analysis in Australia, revealing in initial assays that potassium and magnesium levels in Tibetan soils appear very low, and are a likely constraint to grain production.

A project that has studied the **implications of China internationalising its food economy** has also analysed how China joining the World Trade Organization (WTO) has affected the country's food policies. A general equilibrium model of the Chinese economy with regional dimensions (CERD) that included the eastern coastal, central and western regions described five agricultural subsectors. Findings consistently showed that the trade reforms China adopted in order to accede to the WTO will lead to substantial structural changes within the agricultural sector.

In China, as in other rural-based countries, the main factors behind reductions in rural poverty will be the scope for rural households to earn off-farm income and for people to move from rural areas into industry and services in urban centres. Therefore, to a large extent, the success of the trade reforms will depend upon policies beyond agriculture.
These findings were reinforced by another project involving the International Food Policy Research Institute (IFPRI) in partnership with institutions in China. Together they have developed a **snapshot view of inequality** within and between rural villages in western China, based on a census-type household survey in three administrative villages and a sampling survey of 286 natural villages in the province of Guizhou. They found that, in contrast to coastal regions, **non-farm income** is distributed unevenly in this inland region and accounts for the largest share of overall income inequality.

This finding has important implications for the future strategy in promoting development and poverty reduction in lagging regions. While overall economic development will be the main instrument to bring the majority out of poverty, a targeted approach will be increasingly crucial to help the development of these poor villages and households. It is imperative to understand why they are not participating in the growth process and how development strategies and various transfer programs would help them.

Two forestry projects are using the same plantations to undertake parallel research. They are both focused on **growing trees and processing timber** to provide a higher quality product for use in construction joinery and furniture in China (and also Vietnam). Poor yields result from growth stresses released upon sawing that cause distortion and splitting in logs, so eucalypts in many developing countries are mainly used for fuelwood, pulp and poles. One line of research is focusing on genetic and silvicultural controls to reduce losses.

So far this project has initiated a wood-quality analysis along with an assessment of growth and form at an established spacing and fertiliser trial of cloned trees at Dongmen Forestry Farm. The initial analysis has enabled the research team to identify trees for further wood-quality assessment. Additional support from a Chinese pulp and paper company has extended the project to evaluate the **impact of silviculture on pulp wood production and quality** as well as the original focus on solid wood.

The other project is trialling **sawing and recovery strategies** to get the best from logs, with a particular focus on economic viability. Early in the project five scientists from China and Vietnam attended a training session at the Timber Training Centre in Creswick, Victoria, to gain more skills in eucalypt timber sawing and wood drying, and to learn processing research procedures. While in Australia they visited the University of Melbourne's Centre for Advanced Wood Processing and the CRC-Wood Innovations and were introduced to the microwave pre-treatment technology in solid wood processing. They also visited industrial sites in Victoria and New South Wales and intensively managed eucalypt farm forests in southern and northern Victoria.

ACIAR supports ongoing and new research and capacity-building activities at CIMMYT, ICARDA and PBIC–Sydney University to ensure productivity and food security through **sustainable control of wheat yellow rust** in Asia. The researchers have made significant progress in incorporating durable yellow rust resistance into several cultivars, but they found some cultivars deemed highly resistant in Mexico were either susceptible or just moderately resistant in China.

They therefore devised a shuttle-breeding strategy whereby early generations were grown in Mexico then subsequent generations were grown in China, to speed up the breeding as well as select under high yellow rust pressure in China. This strategy resulted in more lines that were resistant and better adapted to the Chengdu environment. Moreover it developed local capacity to continue the work into the future.

ACIAR has invested heavily in the development of integrated crop management (ICM) systems for **growing brassica vegetables with minimal pesticide** application, using environmentally friendly methods. A recent project has developed world-class decision-support tools (electronic-based and paper-based) for China and Australia for improving the implementation of ICM systems in brassica crops at the farm level. It has built on existing research and extension activities in China and Australia (many of them developed with ACIAR funding). The Chinese toolkit comprises: 1) the Decision-support and Training Multimedia System for Integrated Crop Management in Brassica Vegetables, which is primarily for extension officers; 2) the paper-based Field Guide to Integrated Management of Crucifer Pests, Diseases and Disorders, designed for farmers. The Chinese toolkit is now in commercial production, and so far 8,000 copies of the field guide have been sold and distributed to farmers.

Peri-urban vegetable production is helping to **increase the availability and diversity of fresh vegetables** in the urban centres. But spoilage of vegetables remains a problem, with unacceptable levels of pesticide use and high postharvest losses from fungal and bacterial pathogens. Inadequate washing, grading and packing facilities contribute to the spoilage, as does limited options for disposing of wash-water and waste. Detection and monitoring of risk factors is possible, using polymerase chain reaction (PCR) technologies that apply to both vegetables and wash-water.

A project has used PCR technology to test different washing and handling procedures, and also obtained basic information on the level of contaminating organisms on three vegetable types in the supply chain. The scientists also evaluated the influence of irrigation water on yield, rot susceptibility and quality, and investigated how poor plant nutrition lowered resistance of vegetables to postharvest disease and physiological deterioration. The project team has developed recommendations on washing of vegetables and developed a PCR test for rapidly detecting the presence of the bacteria *Enterococcus faecalis*.

The **FILTER (filtration and irrigated cropping for land treatment and effluent reuse) technique** was developed by CSIRO for Australia to overcome some of the problems in land treatment of wastewater. The system was successfully tested on clay soils, treating primary or secondary sewage, and the extracted water and nutrients used for intensive annual crop-growing. However, FILTER needed performance-testing on non-clay soils and with different wastewaters, and this has been achieved through an ACIAR project.

Results of trials in both Griffith, Australia and Wuqing, China, confirmed that when the FILTER system is installed at sites featuring soil with a high capacity for phosphorus uptake, with a stable soil structure to maintain hydraulic flows and appropriate groundwater conditions, it can reduce pollutants markedly and make the drainage water suitable for reuse (other than for human consumption).

A small R&D activity is supporting collaboration between Australian and Chinese rice breeders in the development of **cold tolerance in rice** varieties for both countries. This is a very high priority issue for both Australia and China. In addition, Australia is transferring new molecular marker technologies to help China boost its cold-tolerant activities. Cold-tolerant varieties will help reduce the substantial yield losses suffered in cold years in both countries, and they have another advantage of needing significantly less water in cold conditions.

5.3 Relationship to the AusAID China strategy

AusAID's new China strategy for 2006–10 has the goal of furthering mutual national interest by supporting China's balanced development policies and working together in the region. It has the three strategic objectives: of building capacity in selected sectors in China, in particular governance, environment and health; enhancing the Australia–China relationship by building institutional linkages; and working collaboratively to strengthen the region.

ACIAR's China program, while maintaining a focus on sustainable resource management in poorer western regions, reflects the strategic objective of building capacity in China, with a strong focus on capacity enhancement in technical and policy issues relating to the environment as it is either affected by agricultural production or in turn affects production sustainability. Governance and collaboration in the region are addressed by a second major emphasis on agricultural development policy issues, particularly relating to trade policy and environmental management. The basis of ACIAR's mode of operation in China is through the development of strong institutional linkages between Australian and Chinese government R&D and policy-making organisations, thus supporting the second strategic objective of the overall Australian aid program in China.

6 Annual Operational Plan 2007–08

GNI per capita	1,740
Population	1,308.0 million
Population 2015/2050	1,393/1,586.7 million
Active Bilateral projects	17
Active Multilateral projects	3

Bilateral actual 2005–06	$3.73 m
Bilateral budget 2006–07*	$3.23 m
Bilateral budget 2007–08**	$2.59 m
Bilateral and Multilateral budget 2007–08	$2.73 m

**Includes co-funding of $0.09 m (Grains R&D Corporation), $0.36 m (Australian Greenhouse Office) and $0.02 m (AusAID)*
***Includes co-funding of $0.09 m (Grains R&D Corporation) and $0.17 m (Australian Greenhouse Office)*

6.1 Key performance indicators (2007–08)

- ACIAR's program in Tibet Autonomous Region is refined by building on initial progress with crop–forage–livestock systems
- Evidence of utilisation of the results of economic, trade and policy-related research by Chinese government policy makers
- Useful genetic diversity for agronomically useful characteristics such as frost tolerance and disease resistance identified in Chinese pea or faba bean germplasm
- Options for economically viable rangeland management practices in Gansu and Inner Mongolia that have positive impacts on rangeland ecology and greenhouse gas emission identified and communicated to stakeholders
- At least 40% of all new projects designed to have components leading to significant farmer or policy impacts within five years of completion

6.2 Medium-term strategy

ACIAR's program in China will focus on sustainability aspects of agricultural production through policy and technical projects on better management of land and water resources in north-western China. In addressing sustainable production the need to raise farmers' incomes through increased productivity and marketability of produce is also taken into account in project design. To maximise poverty reduction, attention will be increasingly targeted on rainfed cropping systems with an emphasis on north-western China (Gansu, Ningxia, Qinghai and Shaanxi). There is a related but broader emphasis on improving agricultural productivity in Tibet Autonomous Region.

In recognition of the evolution of Australia's development assistance relationship with China all new activities will take the form of partnerships that include significant co-investment by our Chinese partners.

ACIAR will make small investments through a China Linkages Scheme to sustain collaborative relationships between teams in selected completed ACIAR projects and to facilitate broader interactions between Chinese partner agencies and Australian agencies in subjects of high priority to both countries. Funding for exchange visits for workshops or other small activities for exposure to Australian agricultural policies, natural resource management practices, institutions and research management may also be provided via Small Research Activities involving China.

6.3 Position

ACIAR has had a program with China since 1984. Major areas of research have included agricultural water management, selection of Australian trees suited to Chinese forestry, improvement and integrated pest management in Brassica crops, studies of livestock production and diseases with a focus on sheep and wool, quality management in stored grains as well as broadacre crop and citrus improvement. Adoption of conservation tillage in some central western provinces has been recognised as part of the solution to improve crop management and reduce windblown dust in Beijing. In 1999, the focus of ACIAR's program shifted towards western China, in line with the need to raise farmers' incomes in this part of China and to better manage land and water resources.

In view of the significant human and financial resources available within the Chinese National Agricultural Research System and the strong mutual benefits to Australia, ACIAR requires projects in China to have significant sharing of costs by Chinese and Australian research providers.

ACIAR will usually seek a funding commitment through case-by-case exchanges of letters at the stage of development of full project proposals. Only a small proportion of the highest priority projects can be supported. Projects chosen must:

- address the highest priority of Chinese partners
- address overall Australia–China development policy (to 'Further mutual interest by supporting China's balanced development policies and working together in the region)
- complement other schemes for China–Australia collaboration, including the AusAID Australia–China Environment Development program, begun in 2006
- be in areas where the overwhelming driver is Australian technical comparative advantage
- complement rather than duplicate activities of other (larger) donors.

Within our stated priority areas, ACIAR will also fund small investments that foster collaborative linkages between activities that have been primarily funded from Australian and Chinese sources. Conservation tillage will be fully considered in this context.

6.4 Australian Inter-Governmental Cooperation

ACIAR projects form only one part of the China–Australia inter-governmental cooperation in agriculture and natural resource management. AusAID's China strategy for 2006–10 has the goal of furthering mutual national interest by supporting China's balanced development policies and working together in the region. It has the three strategic objectives: of building capacity in selected sectors in China, in particular governance, environment and health; enhancing the Australia–China relationship by building institutional linkages; and working collaboratively to strengthen the region.

ACIAR's China program, while maintaining a focus on sustainable resource management in poorer western regions reflects the strategic objective of building capacity in China, with a strong focus on capacity enhancement in technical and policy issues relating to the environment as it is either affected by agricultural production or in turn affects production sustainability. Governance and collaboration in the region are addressed by a second emphasis on agricultural development policy issues, particularly relating to trade policy and environmental management.

ACIAR's mode of operation in China is through the development of strong institutional linkages between Australian and Chinese government R&D and policymaking organisations, thus supporting the second strategic objective of the overall Australian aid program in China.

Other activities that are taken into account by ACIAR, and which may be an alternative source of support for researchers interested in China include:

- the **Australia–China Agricultural Cooperation Agreement** (ACACA, www.daff.gov.au/marketaccess-trade/iac/acaca), jointly administered by the Department of Agriculture, Fisheries and Forestry—Australia (DAFF) and the Chinese Ministry of Agriculture. ACACA provides funding for agricultural exchange projects between Australia and China. The present focus is on projects that demonstrate commercial potential and provide clear flow-on benefits to industry. DAFF has also established an Agricultural Technical Cooperation Program with initial projects in wool marketing and grasslands management. In addition, DAFF has formed a Strategic Partnership Agreement with AusAID to strengthen the whole-of-government approach to development cooperation in the Asia–Pacific region. This Partnership has helped facilitate recent water management assistance projects with China.
- Australian Government Department of Education Science and Training (DEST) 'International Science Linkages program' (www.dest.gov.au/science/isl). This includes competitive grants under the **Australia–China Special Fund for S&T Cooperation**, in which agriculture, biotechnology and environmental research form three of the priority areas. In addition, DEST supports international exchanges, targeted scientific and technological individual visits, missions and workshops to promote S&T collaboration. These are managed by the Australian Academy of Science (www.science.org.au/internat/index.htm) and the Australian Academy of Technological Sciences and Engineering (www.atse.org.au).
- the Memorandum of Understanding on **Scientific and Technological Cooperation in Food Safety**, recently entered into by Food Standards Australia and New Zealand and the Chinese Ministry of Science and Technology.
- the **Joint Declaration on Bilateral Cooperation on Climate Change** between the Australian Greenhouse Office (Department of Environment and Heritage—DEH) and the National Development and Reform Commission for China (www.deh.gov.au/minister/env/2003/mr24oct203.html) which sets out cooperation in technology development and policy. ACIAR and the Australian Greenhouse Office are currently jointly funding two projects (LWR 2003/039, LPS 2001/094) which are relevant to both the agricultural sustainability and greenhouse gas reduction agendas.
- the **State Bureau of Foreign Experts Affairs of China** which is responsible for accrediting international educators in China and for identifying and negotiating training opportunities across the world which will be of benefit to China. The related **China Association for International Exchange of Personnel** (www.china.org.cn) is a government-sponsored institution also engaged in the international exchange of specialised technical and managerial personnel in several areas, including agriculture, science and technology.

6.5 Indicative priorities

ACIAR has consultations with China to establish priorities for research collaboration, including meetings with senior leaders and researchers from the Ministries of Science and Technology, Agriculture, and Water Resources, as well as the China Academy of Sciences, China Academy of Agricultural Sciences, universities and provincial authorities.
ACIAR's China program for 2007–08 has the following themes:

Subprogram 1: Increased water productivity of agriculture in north-western China

- Technologies for improved water-use efficiency, with an emphasis on dryland agriculture
- Policies and institutions for improved land and water use

Subprogram 2: Improved agricultural productivity in Tibet Autonomous Region

Improved crop–livestock systems in favourable areas of Tibet AR

- Economic analysis of crop and livestock development options for Tibet AR

Subprogram 3: Implications of Chinese trade developments for smallholders

- Implications of more open trade and associated economic policy reforms for poor smallholders in China, regional developing economies and Australian interests
- Identification of policy constraints to adoption of research findings

Subprogram 4: China linkages scheme

- Support for small activities arising out of ACIAR research to assist in communicating findings and to complement activities of other Australia–China cooperative programs

7 Projects (summary and progress reports)

7.1 Subprogram 1: Increased water productivity of agriculture in north-western China

Projects:

Active	
ADP/2002/021	Sustainable land-use change in the north west provinces of China
CIM/1999/072	Oilseed Brassica improvement in China, India and Australia
CIM/2003/067	Ensuring productivity and food security through sustainable control of yellow rust of wheat in Asia (CIMMYT)
LPS/2001/094	Sustainable development of grasslands in western China
LWR/2002/094	Promotion of conservation agriculture using permanent raised beds in irrigated cropping the Hexi Corridor, Gansu, China
LWR/2003/039	Improving the management of water and fertiliser for agricultural profitability, water quality and reduced nitrous oxide emissions in China and Australia
LWR/2005/059	Modelling water and solute processes and scenarios for optimisation of permanent raised bed systems in China, India, Pakistan and Indonesia
Concluded	
CIM/1999/094	Improving the productivity and sustainability of rainfed farming systems for the western Loess Plateau of Province
CIM/2000/035	Increased productivity of cool season pulses in rain-fed agricultural systems of China and Australia
FST/2001/086	Assessment of the potential of *Pinus radiata* for ecological restoration of the Yangtze River catchment in Aba Prefecture, Sichuan, China
LPS/1998/026	Lucerne adapted to adverse environments in China and Australia
LWR/2000/120	Institutions and policies for improving water allocation and management in the Yellow River Basin, China
LWR/2002/018	Regional impacts of re-vegetation on water resources of the Loess Plateau, China and the Middle and Upper Murrumbidgee Catchment, Australia
LWR/2002/113	Application of innovative irrigated cropping and soil filtration technology for wastewater reuse and treatment in China
Pipeline	
CIM/2005/111	More effective water use by rain-fed wheat in China and Australia
LWR/2006/076	Improving livelihoods and water productivity through rainwater harvesting for agriculture in north-west China
LWR/2007/191	Improving productivity and sustainability of farming systems in semi-arid regions of eastern Gansu province

ADP/2002/021: Sustainable land-use change in the north west provinces of China

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	Australian National University
Project Leader	Professor Jeff Bennett Phone: (02) 6125-0154 Fax: (02) 6125-8448 Email: jeff.bennett@anu.edu.au
Collaborating Institutions	China National Forestry Economics and Development Research Centre, China
Project Budget	$499,217
Project Duration	01/01/2003 to 30/09/2007 (Project extended from 01/01/2006 to 30/09/2007)
ACIAR Research Program Manager	Dr Simon Hearn

Project background and objectives

Pollution caused by dust has been, and remains, a significant problem in northeast China. Dust-storms, pushed by prevailing westerly winds, begin in China's western provinces. From there the storms are blown eastwards, resulting in air pollution in eastern cities, most notably Beijing, and even reaching as far a-field as Korea and Japan. The dust-storms have their beginnings in land and water resource degradation in western areas of China, lands that spawn the Yangtze and Yellow Rivers.

Estimates put the extent of this degradation at 135 million hectares or approximately 14 per cent of China's land mass. This equates to 30 per cent of total pasture land in China being eroded, desertified or salinised. Of greater concern is that these areas of degraded land are expanding by 1.3 million hectares a year.

Responding to this, the Chinese Government has implemented the Grain for Green Program (GFGP) offering farmers incentives to establish trees and perennial pastures. Uptake has exceeded expectations, putting the financial viability of this program at risk.

The program has not sufficiently answered one key question: what will happen to the farmers in these areas if land use and agricultural practices are not sustainable and profitable? Developing sustainable land use requires farmers to earn an income in the short- and long-term.

Short-term income assistance is on offer through the program, but this will only last five years and there are signs that this may be an insufficient period of time to establish sustainable industries. The challenge is to develop land use practices that address degradation and ensure agriculture can continue sustainably well into the future.

This project is facilitating the development of policies that will ensure changes in land use management in China's northwest provinces that are sustainable in the long term. Sustainability is defined in terms of the financial viability of farming communities, social acceptability and environmental impacts.

Project Progress

Year 4 (01/01/2006–31/12/2006)

The initial project was completed by the end of 2006. Research activities during 2006 included the following.

The farmer livelihood analysis was extended to convert the household based information to a region wide population basis. The value estimates of agricultural production impacts of the Conversion of Cropland to Forest and Grassland Program (CCFGP) on the Loess Plateau were thus derived.

Runoff reductions brought about by the CCFGP in the Yellow River were modelled with the help of hydrologists from China Institute of Water Resources and Hydropower. Based on the biophysical modelling results, the economic costs associated with reduced runoff in the Yellow River Basin were estimated using the water allocation economic model developed jointly by the Australian Bureau of Agricultural and Resource Economics and the Chinese Agricultural Policy Centre. These economic costs are those from the loss in agricultural production in the region due to reduced water supply for irrigation.

These results, together with the non-market value estimates from the choice modelling exercise conducted in 2005, were integrated into a full benefit:cost analysis to identify the impacts on both upstream farmers and downstream potential beneficiaries. This was followed by policy analysis and recommendations for resolving the public good problem of the environmental services provided by the CCFGP to ensure the sustainable land use change in North West China.

The research reports from the above activities (Reports 6–9) are now available on the project website:
http://crawford.anu.edu.au/staff/jb_suslndrr.php.

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

Bilateral

Overseas Collaborating Countries	China, India
Commissioned Organisation	University of Melbourne, Institute of Land and Food Resources, Australia
Project Leader	Dr Phil Salisbury Phone: 03 8344 7315 Fax: 03 8344 4665 Email: psalisburt@optushome.com.au
Collaborating Institutions	Department of Primary Industries, Victoria, Australia South Australian Research and Development Institute, Australia National Research Centre on Rapeseed-Mustard, India NSW Department of Primary Industries, Australia Oil Crops Research Institute, China University of Western Australia, Australia Punjab Agricultural University, India Tata Energy Research Institute, India Indian Council of Agricultural Research, India Huazhong Agricultural University, China Haryana Agricultural University, India Department of Agriculture, Western Australia, Australia Institute of Industrial Crops, China
Project Budget	$2,607,087
Project Duration	01/01/2004 to 31/12/2008
ACIAR Research Program Manager	Dr Paul Fox

Project background and objectives

Oilseed brassicas are an extremely important crop in China and India. More than 6 million hectares are planted to *Brassica napus* (rapeseed) in China and *B. juncea* (Indian mustard) in India. Achieving canola quality oils (low in erucic acid and glucosinolates) is an aim for both countries. *B. napus* varieties grown in Australia, Europe and Canada all achieve canola quality. Of the *B. napus* types grown, those planted in Australia are best suited to Chinese and Indian growing conditions. Germplasm with improved traits for both *B. napus* and *B. juncea* will be tested to improve canola quality oilseed production in China, India and Australia.

Brassica production in all three countries is limited by a number of key diseases and environmental stresses. Sclerotinia and white rust resistance traits are needed to reduce the losses these diseases cause. Agronomic traits such as drought tolerance and quality will also boost yields and oil quality. Molecular genetic and quality analysis can be used to determine key traits including quality, disease resistance and drought tolerance.

This project is:

- identifying and developing effective screening/evaluation protocols for each key trait
- identifying appropriate variability for key traits through use of screening protocols
- enhancing germplasm in all countries for key traits through selection and breeding
- identifying heritability of key traits, genetic distance and heterotic pools (agronomic analysis, molecular analysis) by undertaking genetic variability/distance studies on germplasm from all countries
- developing and providing appropriate information on improved germplasm and disease epidemiology for incorporation into existing technology transfer protocols.

Project Progress

Year 3 (01/01/2006–31/12/2006)

Advances were made in 2006 in the development of screening protocols for sclerotinia and white rust resistance. Severity of sclerotinia infection was found to be related to stem diameter and stem lesion length 3 weeks after inoculation was significantly and positively correlated with the percentage of plant death at maturity, which indicated the value of the stem inoculation method for the effective identification of sclerotinia resistance under field conditions (UWA-B).

Assessment of white rust screening protocols demonstrated that controlled environmental conditions are suitable for rapid identification of resistant genotypes and that genotypes with high levels of resistance can be reliably identified at either the cotyledonary, seedling, or flowering stages (UWA-B). Pathotyping experiments of the white rust pathogen have identified only Race 2 pathotype 2A isolates in Australia to date (UM). Further surveying is underway to determine if the virulent pathotype (2V) is present in Australia.

During 2006 considerable progress was made in the identification of variability for key agronomic, quality and disease resistance characters in the Indian, Chinese and Australian *B. napus* and *B. juncea* germplasm in each country. In addition, breeding programs to enhance the germplasm in all countries for shatter resistance, disease resistance, agronomy and quality and drought tolerance characters progressed. Crossing programs, which were initiated in 2005, have advanced significantly, and the first generation of populations developed from the crosses have been sown and are currently being screened.

Some key characters that were identified in the germplasm screening that will be beneficial to the breeding of improved lines for each country included: white rust resistance in Australian and Chinese *B. juncea* lines; low erucic acid and low glucosinolate levels in Chinese and Australian *B. napus* and *B. juncea* lines; drought tolerance in Australian *B. juncea* lines; variation for sclerotinia tolerance among all *B. napus* lines (varied among locations); potential blackleg resistance in Chinese and Indian *B. juncea* germplasm in Australia.

Cluster analysis of Australian and Indian *B. napus* and *B. juncea* varieties by Harayana and Punjab agricultural universities showed no association between geographical distance and divergence based on morpho-physiological traits, as genotypes from different locations fall in the same group and vice versa, which may be due to continuous exchange of germplasm.

Extensive work was undertaken in China (HZAU, IOCR, XAAS), India (HAU, PAU) and Australia (UWA-C) during 2006 to identify genetic distance, heterotic pools and heritability of key traits in the germplasm. Dendrograms showing the relationships among the 48 *B. napus* lines have been prepared at UWA-C and HZAU. Clustering in the HZAU dendrogram indicated that the Chinese *B. napus* lines were relatively more genetically diverse. Clustering in the UWA-C diagram showed the clear distinction of Indian *B. napus* to accessions from other countries, and a higher proportion of “private alleles” in Indian and some Chinese accessions. Genetic distance analysis of *B. juncea* is also under way at UWA-C.

Crosses have been made for hybrid vigour studies and at most institutes the F1 generations have been sown or will be sown soon. At UWA-C, selections were made for F1 hybrid evaluation based on the most homozygous selfed plants from each accession. Results from India (PAU), indicate that hybrids involving Australian *B. napus* germplasm and Indian non canola types were most productive.

In China, (HZAU), examination of *B. napus* hybrids at the vegetative stage found positive mid-parent heterosis. Analysis of hybrid vigour in *B. juncea* was undertaken in China (XAAS) with diallel crosses using five Australian and five Chinese lines. The productivity of most of the F1s was higher than their parents and although the maturity of the varieties from both Australia and China was similar, the maturity of F1s was later than their parents.

Preliminary data have been generated in China to study the relationship between hybrid performance of *B. napus* and genetic distance. Results from IOCR indicate the performance of hybrids for yield traits was not consistent with genetic distances, although the genetic distances did show correlation with hybrid performance to a certain degree. At HZAU, neither a positive nor negative relationship was observed between molecular genetic distance and mid-parent heterosis for seedling traits of the F1 hybrids.

Further analysis is under way to determine whether or not correlations exist between F1 seedling characters and F1 yield and yield-related characters, and between F1 yield and yield-related characters and their parents' molecular genetic distance.

During 2006 significant progress was also made towards the objective of increasing the skills of scientists collaborating in the project through scientific exchanges. Mr Wan Zhengjie (PhD student), Huazhong Agricultural University, began 5 months of molecular biology training at UWA in Assoc Prof Wallace Cowling's laboratory on 30 October 2006. Mr Wan Zhengjie will work on two projects at UWA: (i) identification of a gene for male sterility in *B. juncea*, and (ii) genetic distance studies on *B. juncea* in the ACIAR project collection. Mr Mei Desheng, Oil Crops Research Institute, Wuhan, began 6 months of molecular biology training at CSIRO Plant Industry with Dr Allan Green in mid November 2006. Mr Mei Desheng's project will involve cloning of a range of fatty acid biosynthesis genes from the *Crambe abyssinica* oilseed species.

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

Multilateral

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 Email: r.singh@cgiar.org
Collaborating Institutions	University of Sydney, Australia International Center for Agricultural Research in the Dry Areas, Syria Global Overseas Collaborators, Global
Project Budget	$1,000,050
Project Duration	01/01/2005 to 31/12/2009
ACIAR Research Program Manager	Dr Paul Fox

Project background and objectives

Wheat is a widely grown crop throughout many parts of Asia. Of the total worldwide areas planted to wheat more than 40 per cent is grown in Asia where it is an important staple food crop. Of the 95 million hectares devoted to wheat cropping almost half this area (some 43 million hectares) is susceptible to stripe rust.

Stripe rust's causal agent, *Puccinia striiformis tritici (Pst)*, can spread rapidly. It is capable of air-borne migration, being carried long distances by wind. The agent can also evolve rapidly to invade new wheat races (those of a common ancestry). Growing numbers of wheat races have proven susceptible to yellow rust. One wheat resistant gene, *Yr9*, present in several wheat races in South, West and Central Asian countries has begun to break down, resulting in millions of dollars of losses from rust.

Current control measures, fungicides applied at the appropriate time in the cropping cycle, are adequate. There are, however, environmental and price constraints, as the chemicals cause pollution and add to production costs. Growing new varieties with rust resistance is likely to produce the most successful control option while addressing cost and environmental constraints. The ability of rust to travel distances, invade new races and break down resistant genes will require the identification and breeding of lines with a new genetic basis for resistance, which is the subject of this work.

The aim of this project is to increase the food security and profitability of wheat production systems in several countries of Asia and to protect the environment and human health through strategies contributing to the sustainable control of yellow rust disease of wheat.

Project Progress

Year 2 (01/01/2006–31/12/2006)

ACIAR funding supports ongoing and new research and capacity building activities at CIMMYT, ICARDA, and PBIC-Sydney University to ensure productivity and food security through sustainable control of wheat yellow rust, caused by *Puccinia striiformis tritici* (Pst), in Asia. Development of new near-isogenic lines (NIL) for greenhouse and field monitoring for genes Yr2, Yr3, Yr4, Yr33, Yr34, Yr35, Yr36 is progressing to fill the gaps in the existing NIL set. NIL for gene Yr8 have been purified and multiplied and for Yr17 purified. Specific gene combinations are also under development.

Data from Yellow Rust Trap nurseries planted at key sites in South Asia, China and Central West Asia/North Asia (CWANA) regions indicate significant variations in Pst populations in these areas. Virulence for Yr17, first detected in Central Asia, is now widely spread. Increasing virulence for Yr3 and its distribution in Pakistan and Afghanistan is a threat to the variety 'Tatara' – the sown area of which has increased recently after the epidemic on 'Inquilab 91' during 2005.

Lack of virulence for some genes that were ineffective previously is a major concern to progress in yellow rust breeding. A unified Yellow Rust Trap Nursery will now be planted in all countries except China which forms a different epidemiologic region with very different cultivars.

Several facultative/winter wheat cultivars grown, or newly released, in various countries of the CWANA region indicated that only a few were resistant at all sites except in Pakistan. This further demonstrated their vulnerability to diverse pathotypes predominant in different areas. Seedling gene postulation work on Central Asian cultivars conducted in Australia identified some of the commonly occurring genes, which have little or no value to provide resistance to some of the races known to occur in the region. Evaluation in Mexico of individual F2-derived F5 lines from crosses of yellow rust susceptible Avocet with four Chinese cultivars that show moderate levels of resistance in China but immunity in Mexico confirmed F3 results that each cultivar carried 1 major gene and 2–3 minor genes.

Significant progress was made in incorporating durable resistance into several cultivars from China. Because these Chinese cultivars are highly resistant in Mexico but either susceptible or moderately resistant in China, we used a shuttle breeding strategy to speed up the breeding as well as select under high yellow rust pressure in China. During 2006 we identified 119 advanced lines with yellow rust resistance and desirable agronomic traits and planted them in replicated yield trials in farmers' fields during the 2006–07 season. Selections were done on 62 new BC1-derived F5 populations involving 13 additional Chinese cultivars from Sichuan and Yunnan provinces during 2006 in Chengdu and over 1000 advanced lines were planted for further evaluation and selection during 2006–07. An additional 94 F4 populations were planted in Chengdu and Kunming following selection in the F2 and F3 generations in Mexico.

The '1st Elite Bread Wheat Yield Trial', containing 28 high-yielding entries with resistance to rusts, was grown at a total of 16 sites in India, Pakistan, Afghanistan, Iran and Turkey to find replacements for cultivars that are now susceptible to new races of yellow rust. Several new lines showed significantly higher yield potential and resistance at most of the sites in each country and were selected by the cooperators for further testing. Seed of high-yielding entries for the '2nd Elite Bread Wheat Yield Trial' was multiplied during 2006 and planted at 30 sites in 11 countries. About half of the entries have shown high to moderate levels of resistance to the Ug99 race of stem rust pathogen.

Incorporation of yellow rust resistance in 21 facultative/winter wheat cultivars from Central Asian countries has been progressing well in Mexico. Populations in various generations from F1 to F3 were planted for either backcrossing or selection under yellow rust pressure in the 2006–07 winter season at Toluca, Mexico.

A training course was organised in Uzbekistan for 20 scientists, mostly from Central Asia, to enhance their capacity in managing rust diseases of wheat and breeding for resistance. A Chinese scientist, Mr. Huazhong Zhu, attended a 3-month advanced training course on wheat improvement in Mexico. R.P. Singh, C. Wellings and A. Yahyaoui interacted with collaborating scientists during visits to various breeding and pathology programs in China and Central Asia.

LPS/2001/094: Sustainable development of grasslands in western China

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	Charles Sturt University, Australia
Project Leader	Professor David Kemp Phone: 02 6360 7525 Fax: 02 6365 7590 Email: dkemp@csu.edu.au
Collaborating Institutions	Gansu Grassland Ecological Research Institute, China Gansu Agricultural University, China NSW Department of Primary Industries, Australia Inner Mongolia Agricultural University, China Chinese Academy of Agricultural Sciences, China University of Queensland, Australia Research Centre for Rural Economy, China Institute of Environment and Sustainable Development for Agriculture, China
Project Budget	$971,603
Project Duration	01/01/2005 to 30/06/2008 (Project extended from 01/07/2007 to 30/06/2008)
ACIAR Research Program Manager	TBA

Project background and objectives

China's western grassland regions provide the basis of the livelihoods of around 40 million people. The per capita income of Gansu, Xinjiang and Inner Mongolia are amongst the lowest in China, in part due to the poor productivity of the grasslands. A severe climate combined with overgrazing limit production, however, it is land degradation that is the main problem. Almost 90 per cent of the approximately 300 million hectares of grasslands are considered degraded. Dust storms, siltation of the Yellow River and declining biodiversity have all resulted and are accelerating and frequency and severity of such storms.

Rehabilitating these grasslands is a focus of Chinese Government policy and supporting international programs. Grasslands management concentrating on livestock farming systems aims to identify better strategies to overcome degradation and improve smallholder incomes.

The project is working to provide research support and training at a range of levels (including scientists, policy makers and extension staff) to contribute to the development and adoption of a systems approach to pastoral management. Achieving this will raise farmer incomes, while sustaining or enhancing the productivity of the resource base, and will help in identifying the priorities for research and development and Government programs by developing:

- a framework for grassland farming systems that integrates the major components that influence grassland use, and
- a suite of policy/regulatory approaches and on-farm strategies that impact positively on farmer incomes and grassland rehabilitation (using the farming systems framework).

Project Progress

Year 2 (01/01/2006–31/12/2006)

This project aims to change the approach to grasslands management by analysis of the grassland livestock farming system to identify better technologies and policies that can be implemented, and the R&D priorities for future work.

Aim: To develop a framework for grassland farming systems that integrates the major components that influence grassland use.

A workshop on the analysis framework was held in Orange, NSW during February 2005 with the key personnel from four organisations in Gansu and Inner Mongolia. That workshop considered the methodology to be used and developed an initial list of the key questions that need to be analysed within the project; broadly grouped within the areas of policy, grassland management, animal management, ecology and economics. Each collaborating organisation in Gansu and Inner Mongolia identified a county/banner from which data would be collected on typical farm structures, based on representative villages. Initial data collection was done during 2005.

The framework developed for analysis of the grassland livestock farm systems includes a Stage 1 Feed Balance Analyser and a Stage 2 Biophysical / Economic analysis.
The Stage 1 models aim to achieve a reasonably realistic description of what is occurring on the farms and to resolve inconsistencies in the data available.

The Stage 2 models use biophysical data (including quantity and quality of forage sources), enterprise budgets and linear programming to identify the optimal combination of resources for alternative farm strategies.

The outputs from this framework aim to rank the choices available for research and for farm improvement. Further discussions on these topics were held with project personnel during the International Grassland Congress in Ireland in mid-2005.

The Stage 1 and Stage 2 models were further developed in 2006 and are now reasonably robust. Both models were substantially revised to overcome some difficulties in the earlier versions and to ensure that sufficient data are collated to provide realistic outputs. They have become teaching tools with our Chinese colleagues to help them work within a systems framework. Advisory staff in NSW have expressed interest in using these models.

Early work has started on the Stage 3 model that will look at the sustainability of the farm systems over a longer term. Emphasis will be on using general relationships to estimate dust storm likelihoods and grassland stability in relation to the grazing pressure.

LWR/2002/094: Promotion of conservation agriculture using permanent raised beds in irrigated cropping in the Hexi Corridor, Gansu, China

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	University of Queensland, Australia
Project Leader	Dr Jack McHugh Email: mchughjack@optusnet.com.au
Collaborating Institutions	China Agricultural University, China Gansu Academy of Agricultural Sciences, China Gansu Agricultural Mechanisation Bureau, China
Project Budget	$600,000
Project Duration	01/07/2005 to 30/06/2009
ACIAR Research Program Manager	Dr Christian Roth

Project background and objectives

Gansu is a north western Chinese province in the Yellow River Upper Drainage Basin. Between Gansu and neighbouring Inner Mongolia, lies a distinct valley, the Hexi Corridor. In the past, reliable snowmelt water from the adjacent Qianlian Mountains has sustained the irrigated agricultural areas along the length of the valley. In more recent times, reduced snowmelt water has led to significant reductions in available surface water, whilst over-extraction and decreased recharge has lowered water tables in groundwater driven systems. As a consequence, severe water restrictions are being placed on farmers (up to 50 per cent reduction in allocations).

Although delivery losses are being reduced, through better channel lining, few practical solutions are being offered to farmers to cope with the policy-driven cutbacks in water allocations, water price increases and pumping costs. Other food production issues associated with water restrictions, such as small farms, low levels of mechanisation, high inputs, conventional tillage, low incomes and the loss of young men to the cities, are placing further pressure on farmer livelihoods. Therefore this project is examining conservation agriculture, using practises such as zero tillage and permanent raised beds (PRB), to reduce irrigation water use, maintain farm yields and improve farmer incomes.

Project Progress

Year 2 (01/07/2006–30/06/2007)

The planter and bed former developed prior to the previous season was modified slightly to cope with frozen soil and high moisture content, and to improve seed/fertiliser separation in the seed bed. Although not perfect, planting for the second season at the Zhangye Research Station and the demonstration site at Shandan County was more successful than that of the previous season, achieving plant emergence in the order of 90% compared to 65% for the permanent raised bed sites in 2006.

The bed former and planting implement were duplicated for the demonstration site in Jui Quan. During the planting operation in March 2007 similar problems were experienced to those in Zhangye and Shandan. Consequently the Jui Quan team has suggested a considerable number of improvements for the planter. Using these recommendations and along with those made previously by Dr Jeff Tullberg, Dr Jack McHugh, Dr HeJin and the designers at the Zhangye Mechanisation Institute (ZMI), there is a newly designed implement to meet the needs of the project.

The new implement will improve trash flow, incorporate depth control and have the flexibility to plant in flat systems as well as raised beds. ZMI has successfully designed, built and tested a tractor-mounted grain harvester. This modular-designed machine can operate in small fields and on raised beds, offering the farmers an inexpensive method of using their own tractor for multiple tasks.

Although the machine requires some modifications in the area of manoeuvrability, driver comfort, and visibility, it appears robust, effective and of commercial value. Some considerable thought has been given to planting wheat after maize and a new permanent raised beds (PRB) planter is being designed, based on those developed by the China Agriculture University (CAU) under the auspices of other dryland CT projects.

There was no significant difference between wheat yield of conventional practice (CT) and PRB even though plant emergence was 20% lower under PRB in the first season. Water use efficiency (WUE) for PRB was 11.2 mm/kg/ha, whereas CT was 9.2 mm/kg /ha. The other treatment's WUE was less than CT at ~8.7 mm/kg/ha.

The 90% emergence observed in the 2007 season at the Shandan demonstration site and Zhangye station should see a considerable improvement in yield overall. Despite emergence at the Jui Quan demonstration site being down to 83% on average, yield estimates for 2007 are equivalent to regional averages.

Levels of total nitrogen, phosphorus, potassium and available potassium in PRB were the highest amongst all the treatments. PRB and zero tillage (ZT) also increased the population of soil microflora (bacterium, actinomyces, and anaerobic cellulose-decomposing bacterium). Based on this information fertiliser quantity was reduced during planting for the 2007 season.

Water balance data have demonstrated 40% irrigation water saving using PRB in the 2007 season, which followed 22% savings during the first season. The first season at Shandan reported an 11% saving of irrigation water followed by a 20% saving on 2007.

PRB consistently displayed increased soil moisture storage after the first month of plant growth, requiring 32 mm less irrigation water on average per irrigation event. Data from salinity probes suggests that there is no build up of salinity in the PRB site at 60 cm depth. Salinity levels CT are twice that of PRB, but well below the threshold salinity tolerance for wheat. Percentage of total salts in the profile in CT was 2.5 times higher than PRB, but similar to ZT sites.

Standing stubble of 20 cm height has been retained on ZT and PRB fields for two seasons at Zhangye research station and a single season at Shandan County demonstration site. The stubble cover at both sites maintained high soil moisture and reduced soil temperatures, hence planting was delayed at both sites by up to a week compared to CT in the first season. The second season saw similar delays, but most of this was caused by the poor performance of the planter in moist and frozen soil conditions with heavy trash. Standing stubble will be reduced to 10 cm in 2008 in an attempt to reduce blockages during planting and raise soil temperatures faster after winter.

Benchmarking was completed at project commencement and final cost:benefit analysis will be conducted toward the project completion date in 2009. The GAMB extension staff are recording farming inputs and based on preliminary data gathered during the establishment phases of the demonstration sites. PRB incurred savings of ~415 Yuan/ha, which included extensive first-year bed-forming. In subsequent years this figure should improve markedly as evidenced by the 744 Yuan/ha saving in ZT fields.

The second demonstration site has been established in Jui Quan City. Planning and discussions are well under way toward the establishment of the third site in March 2008 in Wuwei City. At this stage there is no documented evidence of farmer uptake of PRB. However, the Guangzhou District Government Agricultural Department is setting up a PRB demonstration site near Zhangye City, independent of this project.

LWR/2003/039: Improving the management of water and nitrogen fertiliser for agricultural profitability, water quality and reduced nitrous oxide emissions in China and Australia

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	University of Melbourne, Department of Agriculture and Resource Management, Australia
Project Leader	Dr Deli Chen Phone: 03 8344 4665 Email: delichen@unimelb.edu.au
Collaborating Institutions	Shanxi Academy of Agricultural Sciences, China Chinese Academy of Sciences, China Cardno Acil Pty Ltd., China Office, Australia Chinese Academy of Agricultural Sciences, China China Agricultural University, China
Project Budget	$1,627,826
Project Duration	01/04/2005 to 30/09/2009 (Project extended from 01/04/2009 to 30/09/2009)
ACIAR Research Program Manager	Dr Christian Roth

Project background and objectives

In China irrigated cropping demands careful management of water resources and other inputs. Wheat and maize are the two main irrigated crops grown in western provinces. Water use efficiency in these areas is often low despite water being a critical resource.

The intensive nature of the cropping that is practised demands the use of fertilisers. Nitrogen (N) fertiliser is the main type used but, as with water, its use is often inefficient and wasteful. The combination of water used inefficiently with more fertiliser than is needed creates environmental problems, beginning with nitrogen-rich runoff. Volatilisation of ammonia contributes to nitrogen loss, in turn requiring more fertiliser use. This also results in greenhouse gas emissions.

A Water and Nitrogen Management Model (WNMM) developed in past ACIAR research should help determine changes needed to improve current management practices. By working with the model and its associated decision- support system in two AusAID projects in Inner Mongolia and Hebei provinces, better practices will be identified and then disseminated to farmers through the existing project channels.

The project is improving the management of water and N fertiliser to increase farm incomes, improve environmental quality and reduce N_2O emissions from agriculture. The systems to be studied are irrigated maize and wheat cropping systems and intensive vegetable farms in the western Yellow River basin of northern China, and intensive irrigated pasture and maize, and rain-fed wheat systems in Australia.

Project Progress

Year 2 (01/04/2006–31/03/2007)

Most of the milestones outlined in the project proposal for the second year (of this four year project) have been achieved, and are summarised as follows:

In China:

1. Field experiments on irrigated maize in the Inner Mongolia Autonomous Region (IMAR), in collaboration with the AusAID project “Alxa League Environmental Rehabilitation and Management” have been completed. Using a combination of field measurement, modelling and ^{15}N tracer techniques we found that 25 to 40% of irrigation water, and 186 to 255 kg N per ha of nitrate leached down below the root zone. It was estimated that 50–90% of applied N fertiliser was lost.

2. The water and N management model, (WNMM) has been adapted for simulating water and N dynamics under maize cropping in IMAR. Best management practices for these systems have been identified on the basis of WNMM simulations.
3. Two years of field experiments on water and N dynamics, plant growth and yield have been completed on irrigated wheat and maize at Yongji and Hongtong (Shanxi Province). The data are being used for testing WNMM in these environments.

   The Yongji site is extensively instrumented, including an Eddy Covariance system for measuring evapotranspiration and CO_2 fluxes and a wireless soil moisture monitoring system. The preliminary results indicate that in Shanxi 30 to 160 kg/ha N fertiliser can be saved without reducing maize yields, and the corresponding saving for wheat is 40 to 100 kg/ha. This translates to 120 to 640 RMB/ha cost saving ($A1=6RMB). Similarly, significant amounts of irrigation water can be saved without lowering yield.
4. Open path laser and micrometeorological systems were used for the first time at Yongji to measure NH_3 losses from irrigated maize. Sprinkler irrigation improved water use efficiency and substantially reduced NH_3 volatilisation.
5. An economic sub-model is being constructed and linked to WNMM, using data gathered from a previous ACIAR project (LWR1/1996/164) and new survey data from Fengqu county (Henan province). The combined model will be used to assess the trade-off between environmental and economic objectives, and to assess policy options for water and fertiliser management.
6. Three county-wide surveys in Yuci, Yongji and Hongtong, Shanxi Province have been completed. Soil, land use and village maps have been digitised and most attribute database sets have been compiled. This information is needed for developing the county-scale WNMM model and decision-support system. Landsat TM5 images for 2006 have been purchased to estimate crop biomass, leaf area index and N uptake to calibrate WNMM.
7. The Chinese Academy of Sciences has approved A$500,000 co-funding to establish a state-of-the-art auto-chamber system for N_2O and NOx measurements at the Yongji site. The system will be ready in October 2007 for the start of the wheat season.
8. The University of Wollongong is building a more portable open path FTIR system to simultaneously measure NH_3, N_2O, CO_2, CH_4 and CO. The system will be ready for deployment in the 2008 wheat and maize seasons at Yongji, as well as in wheat, pasture and sugarcane sites in Australia.
9. The Shanxi Agricultural Comprehensive Development Office has funded A$50,000 to assist the social and soil survey in 2007, and has agreed to further funding to support establishment of demonstration farms in Shanxi.

In Australia:

This project complements work funded through the CRC-Greenhouse Accounting, Australian Greenhouse Office (AGO) and GRDC, mainly focusing on model development, measurement methodology and fundamental N process studies.

1. The WNMM has been significantly modified for Australian conditions:
   - The web-based version of WNMM has been completed.
   - The phosphorus sub-routine for WNMM has been developed and tested using the site dataset from Yuci County and will be tested for irrigated pastures in Australia.
2. Applications of WNMM in Australia assisted by this ACIAR project include simulation of water and N dynamics, and N_2O emissions, for rain-fed wheat in Victoria and Western Australia and irrigated pastures in Victoria for AGO programs, and simulation of N dynamics in NSW within the ACIAR project led by Dr Jeff Evans.

Other international applications, in association with the ACIAR project, include: simulating N dynamics and NH_3 volatilisation in rice for South Korea; simulating water and N dynamics for irrigated maize and wheat in the Yaqui valley, Mexico, by Stanford University; simulating N and water in legume systems in China by the Chinese Academy of Sciences.

3. Based on the ACIAR project, an application to the DEST China Special Fund, 'Improving water and agri-environmental sustainability in the Murray-Darling Basin and the North China Plain' was successful ($108,000). Also an additional $120,000 from AGO to fund two open path lasers for NH_3 measurement was awarded.

LWR/2005/059: Modelling water and solute processes and scenarios for optimisation of permanent raised bed systems in China, India, Pakistan and Indonesia

Bilateral

Overseas Collaborating Countries	China, India, Indonesia, Pakistan
Commissioned Organisation	CSIRO Land and Water, Australia
Project Leader	Dr Freeman Cook Phone: (07) 3214 2840, Mob: 0409 613 932 Fax: (07) 3214 2855 Email: freeman.cook@csiro.au
Project Budget	$84,816
Project Duration	01/04/2006 to 30/09/2007 (Project extended from 01/07/2007 to 30/09/2007)
ACIAR Research Program Manager	Dr Christian Roth

Project background and objectives

Permanent raised beds are being used to minimise the effects of water logging, reduce irrigation water and improve the biological and physical health of the soils; all these factors leading to increased productivity of crops.

Design criteria for permanent beds in terms of infiltration and drainage are not well developed and are usually driven by machinery specifications. Fertiliser placement for nutrient and solute management and the risk of build-up salts are additional criteria to be addressed by country partners.

Using two-dimensional water and solute modelling this project will underpin existing ACIAR projects by:

- helping to develop design criteria for optimising bed design from analytical and numerical modelling of water and solute transport
- designing fertiliser placement strategies to maximise fertiliser usage and minimise leaching to ground water
- determining whether salinisation is likely over time in some soil/bed configuration/climate/water quality scenarios.

Project Progress

Year 1 (01/04/2006–31/03/2007)

Annual Report not yet submitted by the Commissioned Organisation.

CIM/1999/094: Improving the productivity and sustainability of rainfed farming systems for the western Loess Plateau of Gansu Province

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	University of Adelaide, Department of Agronomy and Farming Systems, Australia
Project Leader	Dr Bill Bellotti Phone: 08 8303 7728 Fax: 08 8303 7979 Email: william.bellotti@adelaide.edu.au
Collaborating Institutions	NSW Department of Primary Industries, Australia Gansu Grassland Ecological Research Institute, China Gansu Agricultural University, China CSIRO Sustainable Ecosystems, Australia
Project Budget	$1,572,659
Project Duration	01/01/2001 to 31/12/2006 (Project extended from 01/01/2005 to 31/12/2006)
ACIAR Research Program Manager	Dr Paul Fox

Project background and objectives

On China's Loess Plateau a unique combination of slope, soil type, rainfall intensity, and inappropriate agricultural practices has resulted in some of the worst soil erosion in the world. The dominant farming system is a winter wheat monoculture that includes a three-month fallow during the high intensity summer rainfall season. The high rate of erosion is the major cause of heavy sedimentation of the Yellow River. Conservation tillage has much to offer in reducing soil erosion and increasing crop productivity. Replacement of summer fallow with either short season legume crops, or developing rotations around perennial forage crops such as lucerne, also has great potential to reduce erosion and increase whole rotation productivity.

In Australia some farmers using conservation tillage complain of poor vigour of crops. One contributing factor to this is the changed spectrum of disease organisms that can develop in response to changes in tillage and stubble management. There is also strong interest in the use of legumes in cropping systems. Developments in system simulation provide a new and powerful tool for analysis and interpretation of rotation experiments and rotations practised on farm.

Through this project research is working to alleviate poverty in some of the poorest areas in China by introducing conservation tillage. This will also protect land and water resources through conservation tillage and legume-cereal rotations.

Project Outcomes

This project successfully drew together two Institutions who had not previously worked together, with all significant objectives achieved. The following advances were made:

- conservation tillage practices were developed and evaluated in experiments and, more recently, on-farm;
- opportunities were evaluated to more fully integrate legumes into cereal-dominated cropping systems;
- existing simulation models (based around APSIM) were adapted to suit local current and new farming systems and used to explore implications of changes to them;
- research capacity was built in key area of farming system experiment design, analysis and interpretation, participatory action research and modelling.

In China, the results show that no-till with stubble retention (NTS) treatments generally yield as well, if not better, than conventional treatments. They offer farmers the advantages of improved timeliness and reduced labour (and/or fuel) costs. Reduced labour requirements are important, as labour is becoming scarcer with the trend to urban employment and the drift of younger people off the land.

Where yield benefits from NTS occur at the drier Dingxi site, it is in relation to increased plant-available water, although it is not clear whether this results from increased infiltration or reduced soil evaporation. At the wetter Xifeng site, the opportunity to crop more intensively has been demonstrated and placed on a sound scientific footing, based on the dynamics of water and nitrogen, with long-term implications evaluated with APSIM. Most of the benefits of NTS can be achieved immediately – so it is safe to shift research emphasis from understanding soil responses to NTS to implementing systems on-farm and reaping benefits from the research.

Yields across treatments are higher (~50%) than farm yields, suggesting there is good scope to increase farm yields through better management, only part of which is no-till. It is hard to see that nutrition per se is to blame for low farm yields, because fertiliser rates seem high, diseases do not seem to be a major factor, and in these small farm areas weed control is always good. The research, including social surveys and participatory on-farm activities that have just commenced indicate there is also scope to reduce inputs (including fertiliser, fuel and time, and maybe seed), and so increase profit even without increasing yield.

The initial focus of the work in China was to reduce soil erosion through better soil management, but erosion of the cropped landscape is not the issue it first appeared to be, and the greatest benefits of the project lie in the potential to actually increase productivity with a nil or beneficial effect on sustainability. Thus project reviewers recommended that the focus on production and profit should be strengthened, but in the context of soil and water conservation. This is a subtle but important shift in emphasis.

It was agreed that the current lucerne/wheat work had run its course, providing a very solid foundation for any further work. Any new work on lucerne would be in a new project, located in appropriate parts of the landscape, and based on integration into the whole farming system.

The research in China only moved on-farm in the last year of the project, with good results showing that adoption of NTS should not be problematic if suitable no-till planters are available to farmers. In Australia, the work on reduced early growth at Wagga was inconclusive.

Overall, it seems that reduced early growth is not a major factor holding back adoption of no-till in Australia and in China only one crop (peas at Dingxi in 2002) showed any hint of early growth reduction in no-till. In Adelaide, research focused on support for model development and, more recently, work on production and water relations of intercropped wheat and lucerne, in conjunction with the salinity CRC.

CIM/2000/035: Increased productivity of cool season pulses in rain-fed agricultural systems of China and Australia

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	Department of Primary Industries, Victoria, Victorian Institute for Dryland Agriculture, Australia
Project Leader	Dr Robert Redden Phone: 03 53622151 Email: bob.redden@dpi.vic.gov.au
Collaborating Institutions	NSW Department of Primary Industries, Australia Qinghai Academy of Agricultural and Forestry Science, China University of Melbourne, Australia University of Adelaide, Australia Hebei Institute of Cool Season Crops, China Institute for Crop Germplasm Resources, China Yunnan Academy of Agricultural Sciences, China
Project Budget	$1,127,527
Project Duration	01/07/2003 to 30/06/2007
ACIAR Research Program Manager	Dr Paul Fox

Project background and objectives

The rain-fed dry areas of central western China are amongst the poorest in the country. For the people living in these areas sources of animal protein are expensive. The main dietary intake of protein comes from food legumes. Research into this area, however, has been limited, with a focus on cereal crops. Improved pulse varieties are displacing low-quality wheat, in recognition of increased market values placed on pulses.

The role of pulses as both an important food source and a cash crop will become more vital as China's population increases. Estimates place this rise as high as 250 million people. Unfortunately there is no matching scope to increase the area of land under cultivation. Already cultivated land in western China is close to capacity, as well as often being degraded and low in fertility. Increased uptake of food legumes could benefit the farming systems used, increasing soil nitrogen and crop outputs.

Previous ACIAR-supported research has helped improve germplasm disease resistance and some agronomic traits for improved faba bean varieties. With food legumes of lesser importance than cereal crops, research into pulses such as faba and field peas has been minimal. Twenty per cent adoption of pulses in western China is expected once varieties with improved disease resistance and frost tolerance are released.

These varieties are expected to provide a 20-30 per cent yield gain per hectare over current varieties, at no extra cost to the farmer. In addition, Chinese farmers may also obtain up to 30 per cent saving in nitrogen fertiliser inputs to subsequent cereal crops. If these yield increases and cost reductions are realised, this would translate into improved incomes. This project aimed to genetically improve pea and faba bean crops in China and Australia.

Project outcomes

Faba bean and pea landraces were collected in approximately equal proportions of 95 and 93 accessions respectively, from 41 sites in Yunnan (2004), 30 sites in Qinghai (2004) and 66 sites in Yunnan (2005). Data were entered on site physical characteristics, cropping systems and socio-economic features. The new germplasm was divided for Chinese and Australian genebanks.

The Australian Temperate Field Crops Collection (ATFCC) sent 602 unique lines of pea germplasm to China. As well, the Department of Primary Industries (DPI), Victoria pea breeding program sent 305 different elite breeding lines and varieties, while Australian faba bean breeding programs at Adelaide University and DPI NSW sent 44 elite lines.

China provided Australia with a geographic pea core collection of 298 accessions, plus the new collections of 95 faba bean and 93 pea landraces. In both China and Australia, the imported germplasm continues to be assessed and used in their respective breeding programs.

Disease surveys of commercial crop areas were made in Yunnan and Qinghai in 2004, and repeated in Qinghai in July 2005. Major findings for faba bean were: Bean Yellow Mosaic Virus (BYMV) is the major virus in faba bean (60% occurrence in Yunnan, 21% in Qinghai). Other important faba bean diseases were rust and chocolate spot in Yunnan, cercospora and Fusarium root rot in Qinghai and Rhizoctonia in Bashang.

Major findings for pea were: 60% of pea crops in Qinghai had Bean Western Yellows Virus (BWYV), and in Bashang 60% of pea crops had Pea Seedborne Mosaic Virus (PSbMV). On pea, Fusarium root rot was important in Yunnan and Qinghai and powdery mildew in Bashang. Priorities for breeding disease resistance were identified for peas as powdery mildew in all provinces and rust resistance in Yunnan. Disease breeding priorities were only identified for faba bean in Yunnan – for rust, chocolate spot and BYMV. Diseases occurred too late in Qinghai and Zhangbei on both crops to warrant inclusion in plant breeding programs.

Elite pea breeding lines and pea germplasm from Australia (total 650) were assessed in 2005 in each target province – for use both as parents and for placement in 2006 yield trials. A multi-location field trial was designed for a phenotypic comparison of the ATFCC and Chinese pea core collections in Qinghai, Bashang-Hebei and Horsham Australia. This trial was spring-sown in Qinghai and Hebei in 2006 and winter-sown in Horsham in 2006 (where it failed due to drought).

The phenotypes of the Chinese core pea collection clustered separately from the ATFCC core in a multivariate cluster analysis of data from the Qinghai trial. The two core collections of peas were also compared for tolerance to salinity in a semi-controlled environment at Horsham, with 9% of the 799 showing promise. Over 80% of these were from China with half from Sha'anxi province. Newly collected faba bean landraces were assessed by DPI NSW for reaction to Bean Leaf Roll Virus with one out of 18 lines promising, and by University of Adelaide for reaction to Aschochyta with 50% promising as sources of resistance. Some of these landraces were resistant to rust and partially resistant to BYMV. DPI NSW evaluated 32 pea landraces from Yunnan for reaction to PSbMV, with six found completely free. Shuttle breeding of two generations per year was implemented, with the Yunnan pea and faba bean lines grown in an off-season nursery in Bashang, Hebei, and shuttle breeding of pea breeding material from Bashang to Yunnan. Elite breeding lines of faba bean from Australia were evaluated in three provinces in China, and selections from these chosen for use as parents.

The genetic characterisation of 2120 lines of pea germplasm was undertaken at ICGR in 2005-06. Landraces from China had more diverse clusters than from the rest of the world, with one cluster of spring types from north central China, and another of both winter and spring types from western, eastern and southern provinces. For faba bean, AFLP diversity analyses were made on 473 landraces from the CAAS collection of Chinese germplasm and accessions from the rest of the world. Faba bean landraces from China tended to cluster separately from the rest of the world though with a partial overlap.

Each country can benefit from widening of its breeding gene pools to exploit the exchanged genetic resources. Peas from China appear to have previously unrecognised molecular and morphological diversity which is unique to China. Germplasm has been exchanged between CAAS and ATFCC, and this provides excellent plant breeding opportunities to both China and Australia to exploit the other's genetic resources from the respective alternate gene pools. For both peas and faba bean this brings opportunities to utilise new genes and alleles for responding to abiotic/biotic stresses, as well as providing new quantitative trait loci (QTLs) for growth traits associated with expression of grain yield. The findings also raise very interesting questions on the evolution of peas in China, for future investigation.

Training and extension were important aspects of the project. One thousand handbooks with photos, descriptions and control measures for 115 biotic/abiotic stresses of pea and faba bean were produced (in Chinese only) in 2006-07.

FST/2001/086: Assessment of the potential of *Pinus radiata* for ecological restoration of the Yangtze River catchment in Aba Prefecture, Sichuan, China

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	State Forests of New South Wales, Forest Research and Development Division, Australia
Project Leader	Dr Hui-quan Bi Phone: 02 9872 0168 Fax: 02 9871 6941 Email: huiquanb@sf.nsw.gov.au
Collaborating Institutions	Chinese Academy of Forestry, China Sichuan Forestry Academy, China Aba Forest Research Institute, China
Project Budget	$150,090
Project Duration	01/07/2002 to 30/06/2007 (Project extended from 01/07/2004 to 30/06/2007)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Severe erosion has contributed to massive flooding and excessive sedimentation on a number of catchments in China, particularly the upper catchment of the Yangtze River in Sichuan.

Due to the extreme site degradation and the harsh, dry climate of much of the upper Yangtze catchment re-establishment of the natural forest and native species has been problematic, and the Chinese have tested a range of exotic tree species for their suitability as protection forests. *Pinus radiata*, a conifer widely used in Australia in commercial plantations, holds promise.

This project is deploying Australian expertise, in collaboration with Chinese scientists, to aid the introduction and testing of a better range of *P. radiata* germplasm in the Yangtze catchment. The biological risks of establishing the species in such a new environment are being assessed as is developing nursery, field and data management technologies to support the large expansion of plantings planned for *P. radiata.*

Project outcomes

The project team carried out field inspections and assessments in June–July 2004 to evaluate forest health risks to the long-term success of *P. radiata* introduction in the study area. The team consisted of the project leader, a forest pathologist, a forest entomologist and a nursery expert from Australia and their counterparts in China.

Since *P. radiata* was only introduced to the study area about 14 years ago and has been established in widely separated small plantations for environmental purposes, the team examined selected stands to see the level of health issues occurring in these plantations. At the same time, selected stands of native species, *P. armondii* and *P. tabulaeformis*, were also examined because pests and pathogens of these native species were considered more likely to establish on *P. radiata*.

The field inspections and assessments have identified some general and specific health risks to the long-term success of *P. radiata* introduction. The general issue of particular concern is the possible presence of pine pitch canker in China. If verified, there will be an immediate need for internal quarantine, more careful selection of seed sources for future planting programs and on-going targeted forest health survey in existing plantations.

In the long run, developing Sichuan's self-reliance in germplasm of *P. radiata* to minimise the risk of introduction of pathogens will be the option. Other health issues relate to silvicultural practices such as site selection, planting techniques, spacing and quality assurance in planting for better survival and growth. No significant specific forest health risks to the long-term success of *P. radiata* introduction have been identified, although some pests and pathogens were observed in the field.

A report on forest health risks associated with the long term introduction of *P. radiata* in the dry river valley area is being prepared.

Their progress on climate modelling has enabled the scientists to identify areas in Aba and other geographic areas in China suitable for *P. radiata*. The results have shown that much of the Min river valley of Aba is climatically suitable for growing *P. radiata*.

Maps have been generated to show these areas in Aba using the climatic profile already developed for *P. radiata* together with the topographic and climatic data collected last year. Low minimum temperature and low annual rainfall are still the major constraints for radiata pine in some areas. Data from weather stations around Aba have been added to refine the estimates of climates at a landscape scale.

A research paper on assessing climatic suitability of southwest China for ecological plantings of *P. radiata* will soon be submitted for journal publication.

The provenance experiment has been successfully established at three sites along the lower, middle and upper reaches of the Min River valley. The sites were selected and site preparation was completed in late 2003 and early 2004.

Terraces were made along the contours of very steep slope faces. A series of planting pits was dug at even intervals along each terrace. Seedlings of five natural *P. radiata* provenances (Monterey, Año Nuevo, Cambria, Guadalupe and Cedros) were planted in a randomised block design at each site. The survival rate three months after planting was over 98% across the three sites. The seedlings were raised from seeds collected in 1978 by a combined Australia-New Zealand team in the five natural populations of *P. radiata*.

The project team inspected two *P. radiata* nurseries and assessed seedling health and nursery practices. An Australian nursery expert who had detailed discussions with local nursery managers to exchange ideas about improving nursery practices identified the following areas as in need of assistance and training: (a) genotype/source of material, seed pre-treatment management and handling; (b) container types, style and size, growing media composition/materials; (c) general nursery cultural practices such as irrigation methods and mycorrhizal inoculation; (d) seedling nutrition, fertiliser, pesticide and fungicide applications; (e) staff training and quality control processes; (f) specifications and grading of stock.

The Chinese project personnel came to Australia in October–November 2005 on a training mission. The training program had a comprehensive coverage of the process of *P. radiata* production. It included nursery techniques and practices, forest health assessment and monitoring, radiata pine silviculture, stand management, genetic improvement and tree breeding, fire risks and fire management, harvesting, radiata timber processing, pulp and paper making.

LPS/1998/026: Lucerne adapted to adverse environments in China and Australia

Bilateral

Overseas Collaborating Countries	China, Laos
Commissioned Organisation	South Australian Research and Development Institute, Plant Research Centre, Australia
Project Leader	Dr Geoff Auricht Phone: 08 8303 9498 Fax: 08 8303 9607 Email: auricht.geoff@saugov.sa.gov.au
Collaborating Institutions	Department of Agriculture, Western Australia, Australia University of Tasmania, Australia Gansu Agricultural University, China Shandong Academy of Agricultural Sciences, China Beijing Forestry University, China Chinese Academy of Agricultural Sciences, China Gansu Grasslands Ecological Research Institute, China
Project Budget	$1,283,864
Project Duration	01/01/2001 to 31/12/2006 (Project extended from 01/01/2005 to 31/12/2006)
ACIAR Research Program Manager	TBA

Project background and objectives

Sustainable agricultural production is vital for China. As the country develops, demand for animal products is increasing. However, the country faces a severe shortage of forage, and has many environmental problems such as increasing soil salinity, acidity and erosion. The vast grassland areas are not very productive, partly due to inappropriate management but also because of unimproved pasture plants and deforestation.

Australia also has related problems of salinity and waterlogging caused by a lack of deep-rooted perennial plants to keep water tables low. Part of the solution to these problems may come from lucerne, which is a nutritious, productive perennial forage legume, with the potential to improve animal production, increase soil stability and lower water tables. Interest in lucerne is growing, often in places where it was previously considered unsuitable.

Currently, lucerne is sown in 14 provinces in China, and covers 1.33 million ha. It also grows wild in other regions of the country. However, it could be grown far more widely. But the current lucerne is under-utilised, because of the poor performance of the cultivars grown, coupled with a lack of suitable technology and quality seed.

A diverse base of germplasm is already available for lucerne, with a range of tolerances to adverse soil and climatic conditions. But research is required to develop lucerne germplasm specifically adapted for the situations in China and Australia. This large project will target salt, waterlogging, acid/aluminium and cold tolerance by developing new screening techniques and using them to identify tolerant genotypes.

The project aimed to produce lucerne varieties adapted to environmental stresses relevant to China and Australia, through the development of germplasm and novel screening techniques.

Project outcomes

Germplasm characterisation (project germplasm and that from project-supported collection missions) was completed and seed produced ready for distribution. Measurement and assessment of trials have continued at all sites in China and Australia, using the revised measurement protocol. All the Chinese field trial results have now been collated in Adelaide for further analysis. Further trials were established in Laos with the collaborators establishing eight trials across two provinces, three districts and six villages.

Aluminium tolerance screening continued with the several generations of progeny now selected and tested against the parent material. The results of these experiments were exciting—each subsequent generation has increased tolerance over the previous generation. Further selections are continuing, with the aim of releasing a cultivar in 2007.

Evaluation continued of the material in pot experiments with acid soil, as well as of field trials with the early acid-tolerant progeny. The acid/aluminium screening method has been adapted to screen both plants and rhizobia for nodulation at low pH. This is an important advance, since acid-tolerant rhizobia are important for the success of lucerne in acid soils.

Salinity work continued in Tasmania, with a range of parameters measured to characterise the response to salt stress of genetically diverse plant material. Material from different genetic backgrounds appears to have different tolerance mechanisms, and this may reflect adaptation to differing levels of salt stress. Christiane Smethurst had her PhD thesis accepted.

With the extension of the project imminent it was decided to continue trial measurement for another year before making recommendations. The aluminium tolerance screening has already supplied material to breeding programs and retested the progeny of this material. Further selection cycles will continue in 2006. Early generation progeny were included in evaluation trials in 2005.

Adjacent to the 5th project meeting, held in Beijing, a short course was held on lucerne breeding methodology. The result of this course was the development of a breeding strategy for each of the collaborators. The Beijing meeting was followed up with discussions at the project trial sites during the field visits.

A number of project-related papers were published in Chinese journals. Another paper was published from the screening work. Project research was also presented at the International Plant Nutrition Colloquium in Beijing. Project activities and research have featured in a number of articles in Australian electronic and print press.

Funding was again sought from the DEST China–Australia fund to support an extension workshop that would result in the publication of a book on lucerne use in China. The Australian model for this publication, Success with Dryland Lucerne, was translated into Chinese.

LWR/2000/120: Institutions and policies for improving water allocation and management in the Yellow River Basin, China

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	Australian Bureau for Agricultural and Resource Economics, Australia
Project Leader	Dr Steve Beare Phone: (02) 6272 2040 Fax: (02) 6272 2318 Email: sbeare@abare.gov.au
Collaborating Institutions	International Water Management Institute, Sri Lanka Center for Chinese Agricultural Policy, China
Project Budget	$763,191
Project Duration	01/01/2003 to 31/08/2006 (Project extended from 01/01/2006 to 31/08/2006)
ACIAR Research Program Manager	Dr Christian Roth

Project background and objectives

China is poorly resourced with water, presenting a major threat to long-term food security. Predictions indicate that by 2020 grain requirements will exceed current consumption by more than 40 per cent, with livestock demand expected to double. Arable land, however, is almost fully allocated.

Increasing urbanisation, industrial demand and upward income mobility are increasing water consumption. Many of these factors are also resulting in rising levels of water pollution which, coupled with deteriorating irrigation systems and water misallocation, threatens supplies. Imbalances in water resources between regions (the north is arid while further south is comparatively water-rich) further complicate water supply and equity.

Water shortages have been considered from both technical and engineering perspectives, with the Government using innovative delivery technologies to try to increase efficiency. Despite this approach little has changed. Conflicts, and shortcomings of scarce incentive schemes, demonstrate the continuing pressure on water resources.

Institutional limitations, including a lack of integrated, multi-regional approaches or national coordination, are the main factors behind continued water resource pressure. This becomes particularly so given the sectoral approach, with activities in one area often causing shortages downstream. The conflicting needs of industrial, agricultural and urban users further fragment approaches to water allocation.

The project aimed to establish equitable institutional arrangements in the Yellow River Basin (YRB) that promote more efficient water allocations and management, in order to increase the productivity and sustainability of the water resource.

Project outcomes

Theoretical gains from water trading were demonstrated for the YRB. Traditional technical and engineering analysis of irrigation is not enough in the ‘mature phase’ of water use in China. With total abstractions of water for irrigation, domestic and industrial use running ahead of sustainable yield and acute economic and environmental problems in some areas, the research emphasis should now be on socioeconomic and institutional analysis.

The project team identified a range of institutional impediments to dealing with water scarcity in Northern China. Irrigation infrastructure for surface water was often in poor shape. Land and labour constraints needed to be considered in the agenda of reform for surface and groundwater irrigation.

Current impediments to replacing administrative allocation of water in the YRB with water trading include the lack of defined property rights to water, and concomitantly, the absence of any mechanisms to transfer revenue from water sales to potentially exporting regions and/or, at the local level, make transfers to those irrigators most affected by water trade. It was recommended that property rights for water in China be considered at the provincial, county and village levels. Property rights to land also need to be accounted for. Any changes in property rights to water could not occur quickly, suggesting an experimental approach with trials of water trading at the village level. As revealed in the groundwater studies, active water trading is already taking place in villages dependent on groundwater in Northern China.

Resistance to change was hardly surprising given the drastic effects of water transfers on rural incomes (if uncompensated), and the fear and uncertainty that attaches to major policy changes. Even after 15 years' experience of water trading in Australia, commitment to water trade is not as strong at the local level as official rhetoric would have it. In similar vein, the project reviewers anticipated many complex issues in the establishment of China's water rights market.

Perhaps the project's most important conclusion arising from the studies of groundwater in Northern China were that local solutions to water scarcity need to be developed, based on economic and technical assessments of the local situation.

Substantial differences were identified between groundwater areas in the extent of overdraft (water scarcity), implying that any government controls and regulations should be based on metering and monitoring of water levels. Project reviewers noted that remote sensing was a feasible option for enriching the information base available to policy makers on groundwater at potentially lower cost.

An instinctive reaction to emerging water scarcity in Northern China has been to emphasise water saving technology for both surface and groundwater. This approach has been unsuccessful for predictable reasons. Much the same conclusion has applied in Australia where the concept of water use efficiency (WUE) has also been abused.

It was recommended that a more constructive approach to water scarcity would be to consider water use by crop. Straightforward economics of transport and location suggest that high-valued perishable products should be grown close to urban centres. Less water would be required if production of summer crops like maize and cotton were concentrated in wetter parts of China or imported, taking pressure of scarce water supplies.

China has a long history of aiming for self-sufficiency in grain production. While arguments about self-sufficiency and food security are well rehearsed, there are important new ingredients in the risks facing the Chinese economy. China now has a lot of its economy tied to the outside world through imports of industrial raw materials (energy and minerals) and exports of manufactures. Greater reliance on imports of grain, especially feed grain, would now not make as much difference to the political and economic risks facing China as long thought.

LWR/2002/018: Regional impacts of re-vegetation on water resources of the Loess Plateau, China, and the Middle and Upper Murrumbidgee Catchment, Australia

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Land and Water, Australia
Project Leader	Dr Tim McVicar Phone: 02-6246 5741 Fax: 02-6246 5800 Email: tim.mcvicar@csiro.au
Collaborating Institutions	Chinese Academy of Sciences and Ministry of Water Resources, Institute of Soil and Water Conservation, China
Project Budget	$872,795
Project Duration	01/01/2003 to 30/06/2007 (Project extended from 01/01/2006 to 30/06/2007)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Western China's Loess Plateau is a unique combination of soil type, slope and rainfall intensity. Much of the land is too steep for farming. Average farm sizes are small, often as little as 1.5 hectares. The distant and remoteness from potential markets, mainly on the eastern seaboard, eat up any profits in expensive transport costs. Low levels of productivity mean smallholders relying on farming are amongst the poorest in China.

The most far-reaching problem for these farmers is soil erosion. Traditional tillage practices have served to further, rather than limit, erosion. Low levels of perennial vegetation and intense monsoonal summer rains, which dump more than half of the annual fall, also exacerbate the problems.

The large level of rainfall, low vegetation and high erosion all contribute to excessive water runoff. This transports both water and soil sediment into groundwater systems. The most important of these is the Yellow River, its name taken from the colour of the river once the sediment enters it.

Revegetation of the Plateau should alleviate many of the erosion and water/soil losses, but the impacts on hydrology are not clear. Hydrology and erosion interactions are also elements found in the Murrumbidgee catchment in Australia. Understanding these interactions and their impacts at the system level requires complex data interpretation, is best handled by computer modelling.

The project worked to optimise the impact of large-scale revegetation on the water resources of the Coarse Sandy Hilly Region of the Loess Plateau of western China, and in the Middle and Upper Murrumbidgee Catchment of southeast Australia by developing software tools to predict the impact of revegetation strategies on the two regions.

Project outcomes

The key output from this successful project has been the development of a bilingual computer-based simulation tool called ReVegIH (Re-Vegetation Impacts on Hydrology) that allows managers of terrestrial land-use (forestry and agricultural) to understand the regional impacts of current and proposed plans to re-vegetate large areas of the Loess Plateau.

While re-vegetation activities will assist control of soil erosion in the water-limited Yellow River basin, off-sites impacts of reducing water yields need to be acknowledged and planned for. Additionally, to promote use of the tool by the land-use managers, ReVegIH provides suitability assessments of 38 perennial tree and shrub species, and identifies priority and target areas where re-vegetation activities should occur. Thus land-use managers are advised about the 'what and where' concerning re-vegetation activities, and are also provided an assessment of the reduction in water yield these actions will generate.

Extensive consultation with stakeholders from the Middle and Upper Reaches of the Yellow River Conservation Commission, and selected leaders of the county-level heads from Bureau of Forestry, Bureau of Agriculture, and Bureau of Hydrology meant that their functional requirements were taken into account during the design and implementation of ReVegIH. For example, initially a web-based tool was proposed, however, following consultation and feedback from these stakeholders the design was modified to be primarily a CD-based tool that can also be downloaded from the project web-site http://www.clw.csiro.au/ReVegIH. Listening to stakeholders and refining the project plan accordingly has led to greatly increased uptake by regional and county level managers (the so called 'target audience') since the plan's release.

To facilitate the widespread use of ReVegIH, user training was a major focus of the project extension. Two training courses were run, with users being introduced to the underpinning data sets and scientific concepts prior to being trained in how to use ReVegIH to assist in operational re-vegetation planning. Implementation of an adaptive educational model, where feedback from participants of the training courses was sought, has ultimately improved subsequent training activities by addressing the issues identified.

LWR/2002/113: Application of innovative irrigated cropping and soil filtration technology for wastewater reuse and treatment in China

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Land and Water, Australia
Project Leader	Professor John Blackwell Phone: 02 6933 4937, 0427 225355 mobile Fax: 02 6933 2647 Email: jblackwell@csu.edu.au
Collaborating Institutions	China Institute of Water Resources and Hydropower Research, China Department of Water Resources, China
Project Budget	$399,942
Project Duration	01/04/2004 to 30/09/2006 (Project extended from 01/07/2006 to 30/09/2006)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Two thirds of China's total crop production is from irrigated lands. There is, however, increasing pressure on water supplies from the spread of urbanisation and industrialisation. There is also increasing production of wastewater, resulting in environmental pollution. Most rivers, lakes, bays and groundwater sources are showing increasing signs of severe pollution, including from organic matter, nutrients, heavy metals and other toxic chemicals.

As a result water use in agriculture, fisheries and recreation is greatly limited. Reusing effluent in suitable agricultural conditions is a possibility, provided appropriate land treatment and reuse techniques are in place. Soils with impeded drainage are particularly vulnerable to degradation and pollution unless properly managed.

The Australian Filtration and Irrigated cropping for Land Treatment and Effluent Reuse (FILTER) technique was developed for using effluent on soils with impeded drainage. FILTER uses nutrient-rich effluent for intensive annual cropping in combination with filtration of excess effluent through the soil to a sub-surface drainage system during periods of low-intensity cropping and high rainfall.

A past ACIAR project proved the potential of the FILTER technique in China and Australia for sustainable irrigated cropping and nutrient reuse. This project promoted the use of FILTER in Shanxi Province.

The project had three main objectives:

1. to develop and field-test innovative FILTER techniques for sustainable irrigation with wastewater at a demonstration site in Shanxi Province
2. to promote the application of FILTER technology for sustainable irrigation with wastewater in Shanxi and other Chinese provinces
3. to develop simple integrated approaches for siting, design and operation of FILTER and related technology in China and Australia.

Project outcomes

Objective 1 At Yanggao County near Datong city in Shanxi province, a field site consisting of three plots was installed on a farmer's field to evaluate the catchment-FILTER technology. The scientists studied summer, winter and groundwater components, using instrumentation to monitor wastewater and pollutant flows through the soil.

During the summer season a very high hydraulic loading rate of domestic wastewater, around three times the crops' water requirement, was applied to a maize crop established on the FILTER plots. The pollutant removal in the process of wastewater movement through the soil and beyond the crop rooting depth was monitored.

Concentrations of the major pollutants in the wastewater – Total P, Total N, NH_4-N, Organic-N, and COD concentrations – were markedly reduced (by 97, 77, 99, 50 and 75% respectively) in the drainage water flows beyond the root zone.

These pollution removal rates in the Catchment-FILTER system are similar to those previously observed in land-FILTER sites with high water tables in Australia and China. However, due to better soil aeration conditions at this Catchment-FILTER site with deep water tables, the concentration of NO_3-N levels in drainage water increased from zero to around 9 mg per litre, which needs close monitoring in future studies on field adoption of Catchment-FILTER technology.

In spite of the high hydraulic loading rates of wastewater, the maize crop yields of 9.6 tonnes per ha in FILTER plots compared well with district yields of 10.7 t per ha.

During the first winter season, shallow-ponding systems for wastewater infiltration used in north America under freezing conditions were tested at the Yanggao field site, but failed due to the heavy frosts in Datong. During the second winter season, an alternative deep-ponding approach was successful in maintaining an infiltration rate of around 0.2 m per day, with the formation of a 0.3 m floating ice-cap at the wastewater surface.

Soil-water-crop-solute models were applied for predicting wastewater and solute movement through the soil during the summer cropping season. In the second cropping season, the model provided accurate predictions of wastewater and solute flows through the soil profile. Application of the MAIZEMAN model provided accurate estimates of crop biomass accumulation, crop duration, soil water movement and nitrogen leaching.

The potential hydrogeologic impacts of the proposed FILTER system on the surrounding area were investigated. Data available from an existing long-term pond experiment were used to characterise aquifer properties. Boundary flux analysis carried out to quantify the net impact of FILTER on the surrounding areas indicated that a well designed and managed vertical drainage system could be used in a catchment-FILTER approach for domestic wastewater renovation at the site.

There is a need to combine the hydrology modelling with detailed monitoring of biological and chemical contaminants present in the wastewaters, under the management practices proposed and adopted for the Catchment-FILTER site to ensure long-term sustainability.

Objective 2 Promotion of the application of FILTER technology for sustainable irrigation with wastewater irrigation in Shanxi and other Chinese provinces was carried out by the IWHR and SIWR researchers. The IWHR researchers in collaboration with Beijing Water Resources Bureau developed and successfully field-tested an innovative FILTER-polyhouse system to combine the FILTER technology with greenhouse agriculture systems to overcome the low infiltration during winter freezing conditions in north China.

They also field-evaluated a modified land-FILTER system for treating domestic wastewater, in collaboration with Yunnan Environment Research Institute. The FILTER technology was also promoted at discussions with the Ministry of Science and Technology (MOST) and provincial authorities.

Objective 3 Simplified integrated approaches for siting, design and operation of the new FILTER and related technology in China and Australia were developed. These approaches are incorporated into the guidelines for using Land-FILTER and Catchment-FILTER systems for using wastewater in China and Australia.

7.2 Subprogram 2: Improved agricultural productivity in Tibet Autonomous Region

Projects

Active

CIM/2002/093	Intensifying production of grain and fodder in central Tibet farming systems
LPS/2002/104	Increasing milk production from cattle in Tibet
LPS/2005/129	Mineral response in Tibetan livestock
PLIA/2006/184	Finalise uptake of results for improved management of rodents in Tibetan grasslands

Pipeline

LPS/2006/119	Integrated crop and dairy systems in Tibet Autonomous Region
LPS/2007/175	Economic analysis of rural household and development options for the Tibetan Autonomous Region

CIM/2002/093: Intensifying production of grain and fodder in Central Tibet farming systems

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	University of Adelaide, Department of Agronomy and Farming Systems, Australia
Project Leader	Professor David Coventry Phone: 08 8303-7954 , 0417874534 Fax: 08 8303-7979 Email: david.coventry@adelaide.edu.au
Collaborating Institutions	Tibet Agricultural Research Institute, China
Project Budget	$522,702
Project Duration	01/01/2004 to 31/12/2007 (Project extended from 01/07/2006 to 31/12/2007)
ACIAR Research Program Manager	Dr Paul Fox

Project background and objectives

Agriculture in the central area of Tibet Autonomous Region is mainly conducted on the floors and lower slopes of river valleys. Soils are fertile and average rainfall, mostly falling between July and October, is sufficient to support cropping. Barley, wheat, rapeseed, faba bean, maize, vegetables, potato and fodder crops are all grown.

The high altitude of the cropping zone means growing periods are characterised by high sunshine intensity and large divergence between daytime and night time temperatures. These characteristics require specific management practices for cropping.

Current levels of grain production are close to achieving self-sufficiency but need to be further improved as importing of grain to so remote a region is costly.

This shortfall in production also means that livestock are grazed on open grasslands rather than on more beneficial fodder. Livestock production is also a very important component of agriculture in Tibet Autonomous Region. Animal rearing provides opportunities for additional cash incomes, but growth rates are hampered by grassland grazing being the main form of fattening, rather than feeding using fodder crops. This poor nutrition remains an impediment to increased growth, restricting possible cash returns.

Intensifying overall cropping, both of grain and fodder production will result in improvements through the whole system, bringing cereal self-sufficiency closer and improving animal growth to allow access to income from their sale.
This project is optimising the use of resources in cropping for the production of both food-grain crops and fodder crops in central Tibet through careful matching of crop types to the agro-climatic environment.

Project Progress

Year 3 (01/01/2006–31/12/2006)

During 2006, significant progress was again achieved against all project objects – namely, in the ongoing training of staff at the Tibet Agricultural Research Institute (TARI), in developing understanding of the agro-climate and current agricultural practices in Tibet's cropping zone, and in the development of more intensive grain and fodder cropping systems for the zone.

Firstly, the project was able to welcome three new staff members to the Tibetan agronomy team this year – Ms Tse Yang (a Masters student), Ms Pima Drolma and Ms Gou Ying all joined the project over the course of the year. Together with the five staff members recruited during 2004 and 2005, this now brings the number of staff trained within Tibet and Australia through the project to eight.

Australian Youth Ambassador for Development, Samantha Grover, and the Research Officer, Nick Paltridge, both made significant contributions to capacity-building efforts at TARI during 2006, spending five and four months, respectively, at TARI and providing training in research methodology as well as in English language skills. The ongoing development of the young agronomists at TARI remains crucial to the development of a longer term agricultural research program in Tibet.

In addition, a particular focus of Samantha Grover's assignment was to work with counterparts to set up the equipment and protocols appropriate to agronomic research at TARI – for example, balances, a drying oven, a grain moisture meter and a seed counter were all brought into use during the second half of 2006. These advances in human capacity and infrastructure remain crucial to the development of agronomic research in Tibet.

Excellent progress was also made this year in the development of baseline information on Tibetan agriculture. Given the dearth of reliable printed information on local agricultural systems, interviews were conducted in 45 different farming households across central Tibet's cropping zone, exploring demographics, farm resources, the components of cropping and livestock enterprises and associated inputs and outputs. Attitudes to fodder production and system change were also assessed.

These results have provided a more accurate picture of the typical Tibetan farm, informing our ongoing research work and providing a foundation for future efforts in extension. The interview process has also helped shift emphasis at TARI towards more participatory methods in agricultural research.

In related work, and with the help of the Australian Youth Ambassador for Development, soils were described at key experimental sites, and soil samples were taken from farmer fields across central Tibet for nutrient analysis in Australia. An important initial result from these tests is that potassium and magnesium levels in Tibetan soils appear very low, and are probably an important constraint to grain production.

As in previous years, experimental work in 2006 focused on the identification of optimal planting densities and sowing times for intercrops of winter-wheat or -barley with the fodder legumes vetch and lucerne – this time with more emphasis on plant nutrition and weed control.

For the second consecutive year, it was found that excellent grain yields (~6 t/ha) could be obtained at lower cereal crop densities, and in the presence of a relay-sown fodder legumes (i.e., lucerne or vetch sown in the inter-row space of established wheat or barley stands).

Initial data from cereal/lucerne intercrops set up by sowing wheat or barley into established lucerne stands suggest this approach to be unsuitable for grain production, at least with current management, since established lucerne almost completely suppressed cereal growth at the densities tested (single- and double-skip rows at 33, 50 and 66% of normal cereal density).

It is important that these data be validated in 2007, and alternative intercrop management systems evaluated.

Emphasis was also placed on identifying new fodder crops for growth as sole crops in 2006, in collaboration with the FAO and Lan Zhou University. This year, 54 fodder species, mostly new to Tibet, were imported and sown in a replicated trial at TARI, providing a range of new introductions which performed as well as or better as sole crops than existing fodder crops. Success also came from exploring the moisture conditions which best suit the establishment of broadcast-sown vetch, although weather conditions during the 2006 seeding period favoured the establishment of the broadcast seed irrespective of seed treatment or sowing time.

Data from Australian experiments work were limited in 2006, with spring-sown fodder crops failing to germinate due to the extremely dry conditions. However, data were obtained on the relative water use of pigeon pea, forage sorghum and lablab, with a view to assessing their suitability as relay-sown intercrop forages in the south-east of South Australia.

LPS/2002/104: Increasing milk production from cattle in Tibet

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	NSW Department of Primary Industries, Australia
Project Leader	Dr John Wilkins Phone: 02 6938 1837 Fax: 02 6938 1809 Email: john.wilkins@agric.nsw.gov.au
Collaborating Institutions	Tibet Academy of Agricultural and Animal Sciences, China Tibet Livestock Research Institute, China
Project Budget	$452,669
Project Duration	01/07/2004 to 31/12/2007 (Project extended from 01/07/2007 to 31/12/2007)
ACIAR Research Program Manager	TBA

Project background and objectives

Dairy products, notably milk and butter, are traditionally important foods in the Tibetan diet. Demand for these products, particularly milk, continues to rise, driven by changing consumption patterns and, secondly, population growth. Local supply has fallen well behind demand; in winter as much as 60 per cent of butter consumption is of imported products. Milk consumption has also grown by 20 per cent over the last four years. Milk production has traditionally relied on yaks grazed in pastoral lands outside central Tibet Autonomous Region.

The mixed crop-livestock zones of central Tibet Autonomous Region's valleys produced around 35 per cent of milk production in 2003. Recently yak numbers have begun to decline, with cow's milk taking up much of the gap left by lowered supply of yak's milk.

Production in pastoral areas has also declined with an increased expectation that central Tibet Autonomous Region's crop-livestock zone will continue to fill the gap from declining pastoral production.

A specialist dairy sector would help boost production by an estimated minimum of 20 per cent. This can be achieved by improved feeds with greater nutritional value being made available to cattle.

Livestock are largely fed crop residues (straw) and crop by-products and grazed on grasses and weeds, along with crop regrowth. These provide poor nutrition, limiting milk production. Improved feeding systems based around the effective utilisation of crop residues and by-products, better silage management practices, information on yearly feed availability and knowledge of responses to different feeds should achieve the 20 per cent boost in dairy production needed to meet supply and establish a specialist dairy sector.

Through introduction of improved nutrition options the project is increasing milk production and hence farm income from cattle on mixed crop/livestock farms in the valleys of Tibet Autonomous Region. There are ready markets for milk and milk products as local production cannot meet the current demand for these products.

Project Progress

Year 3 (01/07/2006-30/06/2007)

During this reporting period an external review of the project was conducted at a meeting held in Lhasa in May 2007. The meeting coincided with a visit by the Australian scientists from the Agronomy (*CIM/2002/093)* and Minerals *(LPS/2005/129)* ACIAR projects so that all could participate in discussions about future ACIAR funded research in Tibet.

A benchmark study was conducted on 36 smallholder family farms in four regions – Lhasa, Shigatse, Bailang and Naidong, collecting data on feeding, milk production, reproduction, growth and survival rates. Additionally, feed samples were collected from the sites over several seasons and analysed for nutritive value to benchmark local feed quality. Controlled experiments were conducted at TLRI on improving the nutritive value of straw, in the newly established animal house, and on silage production and digestibility at DPI research facilities, Wagga Wagga.

Findings summary

Feed availability:

- Large dependence on straw at all sites and in all seasons
- Proportions of grain in the diet (DM basis) very constant within sites in all seasons – considerable variation between sites
- Lhasa site had opportunistic access to green feed (mainly as vegetable waste) in all seasons.

Milk production:

- Low milk production overall – well below potential (average ~ 5 litres/day)
- Lhasa site much higher production than all others – likely due to greater proportion of green feed
- Bailang site – considerable variation between farms, one much higher
- Shigatse lowest performance
- Naidong around average of all sites
- No difference between cow genotypes.

Reproduction, growth and survival:

- Low birth weights in calves (15–30% lower than expected in Australian cattle)
- Poor survival rates of calves (~60%), and 5–15% death rates in cows
- Reduced fertility in the cows
- Delayed maturity and age at first calving
- Extended calving periods
- Poor growth rates in young cattle.

Wagga experiments:

- Trial severely affected by drought – large variations between plots
- Very little grain development
- Quality data (digestibility) variable
- Protein content increased with vetch component, decreased with increased grain yield – overall lower than expected owing to drought
- Animal house experiment results atypical – severely drought affected silage.
- Experiments need repeating.

TLRI animal house experiment:

- Higher DMI, liveweight gain and dry matter digestibility by processing (chop length) of wheat straw
- Fine chopping significantly increased nutrient utilisation (DMD%).

All production was clearly constrained by poor nutrition – low quality diets. This project has established benchmark data previously unknown to the Tibetan dairy industry (diet composition, milk production, reproduction parameters, survival and growth rates etc.). This now provides a basis for future directions in R,D&E to improve the production and income of Tibetan dairy farms. The provision of the animal house facility will be pivotal to the key research required to develop sustainable feeding systems.

Current feeding systems, heavily reliant on cereal straw, will not allow the animals to express their genetic potential and are therefore constraining farm and industry production. Current systems are also likely to be making very inefficient use of the nutrients offered. Sources of high quality green feed need investigation before annual feed budgets can be formulated, and sources of protein supplements (e.g. NPN) need evaluation.

LPS/2005/129: Mineral response in Tibetan livestock

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	Murdoch University, School of Environmental Science, Australia
Project Leader	Professor Nick Costa Phone: 08 9360 2485 Fax: 08 9310 4497 Email: n.costa@murdoch.edu.au
Collaborating Institutions	Tibet Academy of Agricultural and Animal Sciences, China Chinese Academy of Agricultural Sciences, China
Project Budget	$599,972
Project Duration	01/01/2007 to 31/12/2010
ACIAR Research Program Manager	TBA

Project background and objectives

A survey undertaken in 2005 determined the mineral nutrition status of pregnant sheep, lactating cattle and yaks in the Tibetan Autonomous Region (TAR) of China. The survey team found that livestock were at risk from a number of mineral deficiencies, especially sodium, phosphorus, copper and selenium, with selenium status being particularly low.

These mineral deficiencies could be contributing to the poor to moderate condition of the livestock in TAR, with marginal deficiencies resulting in reductions in growth rate, wool production, fertility and milk production, while severe deficiencies resulted in rapid weight loss and increased mortality. The economic and social costs of these disorders are difficult to assess, particularly since marginal disorders are not readily identified in the field and in addition, there is a dearth of information on the response to supplementation.

Research capacity development and the ability to analyse biological samples for all minerals is an important component of this project. Survey and mineral response trials will involve field work with the most important livestock species in Tibet, i.e. yaks and sheep, using methods developed by Tashi et al. in 2005. Planning of adoption pathways for farmers in Tibet will centre on direct demonstrations and talks to farmers, interim and final reports for ACIAR, and publication of results in international refereed journals.

The aims of the project are to demonstrate the production benefits of improved mineral nutrition of livestock in TAR and to build local capacity to address these problems in future. Specifically it will work towards the following objectives:

Objective 1: To refine information on the mineral nutrition status of livestock in the 4 major livestock production regions of TAR. (About 30% of the field program).

Objective 2: To determine the response to selenium, copper and iodine supplementation in sheep and to selenium and copper in yaks. (About 70% of the field program).

Objective 3: To build the research capacity and extension capability of TAAAS personnel.

Project Progress

First progress report due in 2008.

PLIA/2006/184: Finalise uptake of results for improved management of rodents in Tibetan grasslands

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Sustainable Ecosystems, Australia
Project Leader	Dr Tony Arthur Phone: 6242 1793, mob: 0419 402 278 Fax: 6242 1565 Email: Tony.Arthur@csiro.au
Project Budget	$15,000
Project Duration	01/01/2007 to 31/05/2007
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

An earlier ACIAR project worked to improve the efficiency of rodent control. Various species of rodents and other small mammals have contributed to the degradation of grasslands in western China, which if not contained will lead to major productivity losses - for many decades at least and possibly indefinitely. That project helped to equip personnel at the Tibet Bureau of Agriculture and Animal Husbandry and the Tibet Academy of Agriculture and Animal Sciences for developing environmentally sustainable rodent control systems.

This small R&D activity is finalising results of that project, helping to determine how long-term, large-scale changes in management of the grasslands can lessen the impact of these rodent species.

Project Progress

First progress report due in 2008.

7.3 Subprogram 3: Implications of Chinese trade developments for smallholders

Projects:

Active	
ADP/2004/044	Economic analysis of technical barriers limiting agricultural trade of China (IFPRI)
ADP/2004/045	Exploring alternative futures for agricultural knowledge, science and technology (KST) (IFPRI)
Concluded	
PLIA/2005/123	Trends in world agriculture to 2030, implication for developing countries
Pipeline	
ADP/2005/070	Trade liberalisation impacts on smallholder incomes, employment, productivity and public good needs in Indonesia and China
ADP/2007/022	Trade liberalisation: curse or blessing for water resources management? Impact of trade liberalisation on national and basin water use under global environmental change
PLIA/2006/022	Finalise uptake of results for improved management of rodents in Tibetan grasslands
PLIA/2006/135	Trends in world agriculture to 2030 in India, China and Indonesia (IFPRI)

ADP/2004/044: Economic analysis of technical barriers limiting agricultural trade of China

Multilateral

Overseas Collaborating Countries	China
Commissioned Organisation	International Food Policy Research Institute, USA
Project Leader	Dr David Orden Phone: +1 202 862 8160 Fax: +1 202 467 4439 Email: d.orden@cgiar.org
Collaborating Institutions	Australian National University, Research School of Pacific and Asian Studies, Australia Renmin University of China, Department of Agricultural Economics, China
Project Budget	$175,921
Project Duration	01/07/2005 to 31/12/2007 (Project extended from 01/01/2007 to 31/12/2007)
ACIAR Research Program Manager	Dr Simon Hearn

Project background and objectives

World Trade Organization rules include regulations to protect human, plant and animal health. Some of these regulations act as technical barriers to trade (TBTs) – those designed as legitimate means to protect against the spread of diseases, contaminants and the like. These TBT measures should be based on objective scientific evidence and minimise trade distortions.

Some TBTs impose undue costs and requirements on developing countries adopting sanitary and phytosanitary SPS) measures to promote trade. These SPS measures, set by trade partners as entry requirements for agricultural produce, have created challenges for many developing countries. In cases where these may be used as an unjustified barrier to entry, WTO processes allow for both informal and formal processes of appeal and settlement.

The onus is on the appellant to prove they meet these requirements. One element that can strengthen the argument of developing countries is designing production systems that meet international standards. These must engage producers throughout the system, from large-scale to smallholders.

China has registered six informal challenges to TBTs from other countries, with growing concern within the country that SPS regulations are being used to restrict its trade options.

Helping China better place itself both to assess technical barriers and develop strategies to meet these, together with the use of risk assessment in assessing production-process requirements for its own producers, should result in increased opportunities for trade.

To improve the performance of China's regulatory regime concerning technical barriers to agricultural trade, the project is improving agricultural export performance in labour-intensive, high-value products by enhancing knowledge of the technical barriers China faces and the opportunities that exist for expanding trade.

Project Progress

Year 2 (01/07/2006–30/06/2007)

The issue of the safety of products exported by China has been much in the international news during the past year, demonstrating the value of careful analytic work addressing these issues. During the second 12 months of the project, progress has been made in four dimensions.

First, a preliminary report was completed, which provided an initial inventory of technical barriers facing agricultural exports from China that may be alleviated either by changes of regulations or by adoption of new technologies or compliance procedures by exporting firms. The report also described the food regulatory systems of China. A second round of two weeks of field research was also undertaken to further develop this report.

Second, additional work was undertaken, to specify conceptually the basic methodology proposed for the study as an economic model and to complete an analysis defining the studies proposed for specific cases of Chinese exports.

Third, analysis was initiated to assess the impacts of existing and potential North American SPS regulations on the importation of fresh apples from China. Expanding apple export opportunities has been a high priority of Chinese agricultural trade authorities.

The background literature review on apple trade initiated in Year 1 was further developed. The history of recent regulatory decisions concerning apple and pear exports from China, and subsequent trade, was reviewed and analysed with a focus on the United States, Canada and Australia. Field research was undertaken to further understand the export requirements and procedures for Chinese apples to various countries.

Fourth, several papers presenting the basic methodology and related empirical application were presented at international conferences and finalised for publication.

ADP/2004/045: Exploring alternative futures for agricultural knowledge, science and technology (KST)

Multilateral

Overseas Collaborating Countries	China, India
Commissioned Organisation	International Food Policy Research Institute, USA
Project Leader	Dr Mark W Rosegrant Phone: +1 202 8625621 Fax: +1 202 4674439 Email: m.rosegrant@cgiar.org
Collaborating Institutions	Australian Bureau for Agricultural and Resource Economics, Australia Center for Chinese Agricultural Policy, China World Bank, USA National Council of Applied Economic Research, India
Project Budget	$590,209
Project Duration	01/06/2005 to 30/06/2008
ACIAR Research Program Manager	Dr Simon Hearn

Project background and objectives

How agricultural knowledge, science and technology (KST) reach end-users, particularly farmers, remains poorly understood. While technologies have introduced a variety of improvements and science continues to deliver new knowledge, innovations likely to help many farmers, fishers and others have yet to reap benefits.

The gap between the developed and developing worlds can, in part, be narrowed through agricultural productivity improvements reaching poor farmers. In many developing countries, however, the means to increasing production has failed to reach poor farmers, with KST not delivered in a suitable format.

An increasing level of uncertainty stemming from a variety of factors – changing socio-political environments, shifts in public and private investment, population and economic growth and avenues or pathways to adoption – mean future delivery of KST will need to be well understood.

Of these factors it is the last – avenues or pathways to adoption of KST – that this research seeks to illuminate. Alternative development pathways to agricultural KST adoption will be developed, catering to likely future trends. The implications of these on policy options and investment strategies, including economy-wide trade and subsidy policies, will be examined.

Descriptive narratives to support these scenarios will be used, along with modelling of these scenarios. This will be undertaken in close collaboration with the two-year International Assessment of Agricultural Science and Technology for Development (IAASTD) initiative.

The project is providing policymakers with options of alternative policies and investments for agricultural KST, based on the analysis of alternative development paths and their implications for food security, rural development, and environmental sustainability.

Project Progress

Year 2 (01/06/2006–31/05/2007)

Project objectives are: 1) to develop 4–5 alternative development paths or scenarios for agriculture and related KST policies out to 2050; 2) to develop quantitative scenario results using the models proposed for this project; 3) to analyse the results of both quantitative and qualitative scenario outcomes and to develop implications for investment based on these outcomes; 4) to analyse the economy-wide implications of trade and subsidy policies within these scenarios; and 5) to disseminate research results.

The project is being implemented in close collaboration with the 2-year IAASTD initiative (www.agassessment.org). Outputs under Objectives 1 and 2 were achieved during the first reporting period (1 July 2005–1 July 2006), and Objective 3 and part of Objective 4 were partially achieved during this reporting period. One change in November 2006 has led to a change in outcomes of Objective 1. The Bureau of the IAASTD decided to replace the approach of four to five storylines with the development of a reference or baseline run combined with the analysis of a series of policy issues.

Activities under Objective 3 include the analysis of final model results, and the development of investment implications for alternative scenarios and KST implications. Outputs under this objective include a report on the analysis of model results, a report on final scenario outcomes, and implications for investment. Activities under Objective 4 include the analysis of implications of trade and subsidy policies within the scenarios, in particular, for food production and food security.

Feedback effects between the global CGE model (ABARE's GTEM model) and the global partial agricultural equilibrium model (IMPACT) were implemented, as were additional feedback loops between an Integrated Assessment model and IMPACT. This was a project activity lagging behind from the first reporting period. Moreover, a draft chapter with five storylines was submitted in August 2006. A second draft was submitted in April of 2007 replacing the storyline approach with a reference world or business-as-usual approach, together with six quantitative and six qualitative policy issues.

Quantitatively assessed policy issues include climate change policies and agriculture, trade policies and international market constraints, investment in agricultural KST, bioenergy, water productivity, and changing preferences for meat and certified organic products.

Qualitative assessments included: agricultural resource management and land tenure issues, food safety and food security, biotechnology and biodiversity, information and communication technologies and local knowledge, urbanisation and migration, and the interface of human, animal, and plant health.

Investment calculations have been implemented, but have not yet been submitted to IAASTD. Two alternative trade scenarios have been developed for IAASTD, but a separate report on trade and subsidy scenarios has yet to be developed, and has been slightly delayed.

One of the most surprising outcomes of the chapter is that long-term trends of global food supply and demand indicate a tightening of world food markets and growing resource scarcity combined with continuing increases in demand for the first time in many years. They indicate long-term increasing food prices for major staple crops and meats.

PLIA/2005/123: Trends in world agriculture to 2030, implication for developing countries

Bilateral

Overseas Collaborating Countries	China, India
Commissioned Organisation	Centre for International Economics, Australia
Project Leader	Dr Andrew Stoeckel Phone: (02) 6245 7800 Fax: (02) 6245 7888 Email: astoeckel@thecie.com.au
Project Budget	$30,000
Project Duration	01/11/2005 to 29/12/2006 (Project extended from 30/06/2006 to 29/12/2006)
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

China has become the 'OPEC of the world on the demand side' for commodities, and India looks set to take off and follow. Together, they have the potential to alter world agriculture markets greatly. Analysing these developments, and understanding the importance of these and other global drivers, is crucial for sound strategic planning in rural industries.

The overall objective of this research was to analyse the major drivers behind the trends in world agricultural production and consumption to 2030.

This was undertaken in two parts: firstly a scoping-study to define the project in light of other world research, which involved workshops in China and India to crystallise the issues, identify other partnering institutions, and specify the drivers affecting world agricultural markets in 2030. Secondly, the information gathered was disseminated through publications, seminars, meetings and conferences.

Project outcomes

As the world changes so do the demands and supply of food. Rising populations and incomes change demands. Changing technology, land availability, water and other inputs like energy impact on the type and amount of food that can be grown. Environmental pressures are yet another factor affecting the future supply of food.

Matching demands and supplies of food is mostly left to markets and trade within and between countries, but there is extensive intervention by governments at every level of the supply chain in the production, distribution and consumption of food.

With so many changes in population, incomes, technology and policy, major issue is what the outlook for agriculture is like over the next 20 to 30 years. The FAO projects food supplies and demands for the next 20 to 30 years on a regular basis. But these projections rely on many assumptions that do not necessarily hold true today.

For example, the price of oil was assumed to be exogenous and to fall in the FAO's latest projections of world agriculture to 2030. And the rising population and incomes used in that study that were to 'drive' the demand for food were assumed not to affect the demand for oil. Yet we know that agriculture is more 'oil intensive' than most other sectors through its direct uses such as machinery and transport and indirect uses such as its use in making fertiliser.

This study is a review of the methodology used by the major institutions in the world projecting the outlook for agricultural products over the next two or three decades. The approaches taken and the main assumptions are examined along with a discussion of the possible consequences of treating some factors as exogenous. A more complete treatment (in other words, endogenising some of the critical factors treated as exogenous) is discussed along with the scope of such a study.

This scope includes a discussion of a preferred framework and what a more complete treatment could involve by way of country and commodity coverage.

7.4 Subprogram 4: China linkages scheme

Projects:

Active

PLIA/2006/151	Establishment of beef on red soils in China
PLIA/2006/152	Improved cold tolerance in rice in China and Australia
PLIA/2006/153	Soil filtration technology adoption in China

PLIA/2006/151: Establishment of beef industries in an additional 10 red soil provinces in China

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Livestock Industries, Australia
Project Leader	Dr Bob Hunter Phone: 07 4923 8142 Fax: 07 4923 8222 Email: bob.hunter@csiro.au
Project Budget	$46,468
Project Duration	01/03/2007 to 31/12/2007
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

ACIAR has supported several large projects to find productive enterprises for smallholder farmers in the degraded Red Soils region of southern central China. The outcomes have been successful selection of plants species for livestock feeding. Now the Jiangxi Agricultural University and Red Soils Research Station are distributing many tonnes of seed and cuttings to smallholder farmers and are making additional plantings in an endeavour to meet the strong demand. Training of extension staff and farmers alike is increasing with support from Chinese funding. This small R&D project to establish beef industries in an additional 10 red soil provinces in China was recommended as a finalisation linkage activity arising from the earlier research.

Project Progress

First progress report due in 2008.

PLIA/2005/152: Australia-China linkage for improved rice cold tolerance

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	NSW Department of Primary Industries, Yanco Agricultural Institute, Australia
Project Leader	Dr Russell Reinke Phone: (02) 6951 2516 Fax: (02) 6951 2559 Email: russell.reinke@dpi.nsw.gov.au
Collaborating Institutions	Liaoning Academy of Agricultural Science, China Diversity Arrays Pty Ltd, Australia CSIRO Plant Industry, Australia Guangxi Academy of Agricultural Science, China
Project Budget	$99,796
Project Duration	01/05/2006 to 30/06/2008
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

This small research activity will support important collaboration between Australian and Chinese rice breeders in the development of cold tolerance in rice varieties for both countries. This is a very high priority issue for Australia and very important in China. In addition it will transfer new molecular marker technologies to China from Australia which will have an impact on their cold-tolerant activities and all plant breeding activities in China. Cold-tolerant varieties will lead to prevention of substantial yield losses in cold years in both countries and also allow farmers to significantly reduce water applications to crops.

Project Progress

Year 1 (01/05/2006–30/04/2007)

The project only started in June 2006 but progress is as planned. A rice cold tolerance workshop is to be held in Australia December 4–8 2006. An organising committee has been formed and a tentative program of lab visits and formal presentations outlined for the week-long workshop. Additional funding (approximately $15,000) has been obtained from the Rural Industries Research and Development Corporation to support the participation of three rice cold-tolerance researchers from Japan and South Korea.

PLIA/2006/153: Evaluation of catchment FILTER pilot study in Shanxi, China

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	Charles Sturt University, Australia
Project Leader	Dr Shahbaz Khan Phone: 02 6960 1578 Email: shahbaz.khan@csiro.au
Collaborating Institutions	Department of Water Resources, China
Project Budget	$51,350
Project Duration	04/06/2007 to 30/06/2008
ACIAR Research Program Manager	Dr Jeff Davis

Project background and objectives

In Australia, the Land-FILTER (Filtration and Irrigated cropping for Land Treatment and Effluent Reuse) technique was developed and field tested for treatment and reuse of primary/secondary treated sewage effluent, on soils with impeded drainage. The system can be managed to provide adequate pollutant removal in subsurface drainage water, and to ensure long-term sustainability of the system.

The LWR/2002/113 project at Datong in Shanxi Province clearly demonstrated the two-dimensional Land-FILTER technology could be modified into the three-dimensional Catchment-FILTER approach for wastewater renovation and reuse in the northern China provinces, where there are more permeable, freely-draining soils, very cold winter conditions and wet summers which diminishes the need for wastewater irrigation.

The Shanxi Province wastewater management authorities were successful in obtaining central government funding to install a pilot project of the catchment-FILTER technology, and the main purpose of this new activity is to provide collaboration between the wastewater management authorities and Australian researchers, to ensure the best field application of the FILTER technology in Shanxi.

Project Progress

First progress report due in 2008.

7.5 Subprogram 5: Other

Projects:

Active	
CIM/2000/038	Use and improvement of sugarcane germplasm
FST/1999/095	Improving the value chain for plantation grown eucalypt sawn wood in China, Vietnam and Australia: genetics and silviculture
FST/2001/021	Improving the value chain for plantation grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying
FST/2001/086	Assessment of the potential of *Pinus radiata* for ecological restoration of the Yangtze River catchment in Aba Prefecture, Sichuan, China
HORT/1999/081	Reducing spoilage and microbial contamination of fresh vegetables in China and Australia
Concluded	
ADP/1998/128	Achieving food security in China – implications of WTO accession
HORT/1998/140	Postharvest handling and disease control in melons in China and Australia
HORT/2002/016	Improving the implementation of integrated crop management in Brassica vegetables through a decision support toolkit based on end-user needs in China and Australia.
Pipeline	
ADP/2007/055	Improving the efficiency of land use change policy in China

CIM/2000/038: Use and improvement of sugarcane

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Plant Industry, Australia
Project Leader	Dr Phillip Jackson Phone: 07 4753 8592 Fax: 07 4753 8600 Email: phillip.jackson@csiro.au
Collaborating Institutions	Yunnan Sugar Research Institute, China Bureau of Sugar Experiment Stations, Australia Guangzhou Sugarcane Industry Research Institute, China CSR, Australia
Project Budget	$1,411,755
Project Duration	01/07/2002 to 31/12/2007 (Project extended from 01/07/2007 to 31/12/2007)
ACIAR Research Program Manager	Dr Paul Fox

Project background and objectives

The sugarcane industry is large and economically important in southern China, where sugarcane is currently the second most important crop and its relative importance is expected to rise in the future. Sugarcane industries continue to rely heavily on development of new and more productive varieties to maintain industry viability in increasingly competitive world markets. Sugar industries have invested heavily in breeding programs in the past to maintain a steady flow of more productive varieties. However, parent clones within industry breeding programs around the world trace back to the same relatively small number of key ancestors.

This small sample of genetic diversity in breeding programs, combined with an awareness that there are many desirable traits in exotic sugarcane-related germplasm, has led to strong interest in introgression of new sources of germplasm in breeding programs in Australia and China. In China, large-scale collection of sugarcane-related germplasm from the wild, especially from southwest China, occurred during the 1980s and 1990s, and most of this material is now housed in collections.

Chinese and Australian sugarcane breeders expect that many of these clones will contain individual traits and genes of commercial value if these could be identified and recombined in other agronomically suitable genetic backgrounds.

This project is providing more productive sugarcane varieties to growers and sugar industries in China and Australia by assessing genetic diversity in sugarcane germplasm collections and using wild germplasm to develop improved sugarcane clones.

Project Progress

Year 4 (01/07/2005–30/06/2006)

The project is proceeding in five linked activity areas, corresponding to each of the five objectives. Progress in each area is summarised briefly below.

1. To assess genetic diversity in germplasm collections and select a core set of clones for future breeding.

Data collation needed to characterise genetic relationships among germplasm collected from China and other parts of the world has been completed, with reporting and manuscript writing progressing. A paper on characterisation of the diversity within Saccharum spontaneum was presented at the ISSCT Sugarcane Breeding and Germplasm conference in Ecuador in May 2006. A manuscript for submission to a journal on these data is also being prepared.

In summary, the results highlighted extremely high genetic diversity within S. spontaneum (in relation to S. officinarum and commercial sugarcane), and also showed two general groupings corresponding to clones collected in Southern India and Indonesia on the one hand, and northern India and China on the other. A manuscript on characterisation of the genetic diversity within Erianthus arundinaceus is still in the early stages. As indicated in the previous annual report, the results from the Erianthus study showed that the Chinese representatives of this species are genetically diverse compared with material in the Australian collection; the latter material being mostly sourced from Indonesia. Within China, there is a clear general difference between clones collected in eastern versus western regions. A paper on the relationship of the Chinese species Erianthus rockii in relation to other species in the Saccharum genus was published.

Following an agreement for exchange of basic germplasm clones between China (YSRI) and Australia (BSES-CSIRO) made in 2004, a selection of clones for exchange has been made and these have been placed in quarantine.

2. To develop improved clones derived from wild germplasm.

As indicated in the previous annual report, this component of the project has been successful in producing a wide range of clones derived from wild germplasm, which are now being further evaluated and used within sugarcane breeding programs in China and Australia. This includes the first reports in the world of introgression of *Erianthus* spp. into sugarcane, which opens up new diversity to sugarcane breeding programs.

Field trials in China and Australia to evaluate progeny from *S. officinarum* commercial sugarcane x *S. spontaneum* developed in this project were sampled and measured in 2006. These experiments have been successful, and the better clones from these trials will be evaluated further and used in crosses with elite sugarcane parents.

High correlations between families in the trials in Australia and China for stalk weight and sucrose content were observed.

This result is important. Apart from being the first report of genetic x country interactions in sugarcane, it also indicates that selection trial results in either country will be useful for predicting performance in the other, and has important implications for planning further cooperation to maximise mutual benefits from joint exploitation of the germplasm resources generated in this project in future years.

The evaluation, further breeding, and commercial extension of progeny from Component 2 in this project are all required to realise commercial and social benefits from the success achieved in this area of the project. In both China and Australia, but particularly the former, there is rapidly emerging interest in producing energy sources (especially ethanol) from sugarcane: this is emerging as a major national goal in China, for economic, environmental and national security reasons. Possible characteristics of some clones developed in this project (high dry matter yields, drought tolerance, strong ratooning ability, and other traits) mean there may be significant opportunities arising from this project in this regard.

Further discussions within the project team and with other parties will occur soon in relation to this, aiming to establish if any mutually beneficial R&D opportunities exist. It is worth noting that many poor regions in western China could benefit strongly from the emerging opportunities to produce ethanol from crops.

3. To evaluate DNA marker assisted introgression of exotic germplasm in sugarcane improvement.

This component aims to assess and develop methods for marker-assisted introgression in sugarcane through several case study breeding populations. Populations have been produced in prior years and were successfully established in replicated field trials in Yunnan, Guangzhou and Australia in 2004–2005.

In Yunnan, two populations derived from a *S. spontaneum* clone are being grown. One of these populations is also being evaluated in Australia. In Guangzhou, two populations derived from an *Erianthus arundinceus* clone are being evaluated.

These populations were sampled in November to December, 2005, in China, and in July 2006 in Australia. Analysis of variance of the results from China indicates that the data obtained are of good quality (high broad-sense heritabilities for key traits) and will provide a good basis for subsequent analysis when collection of marker data is completed in 2007.

4. To undertake Gee studies between China and Australia.

Following transfer through quarantine, and two cycles of propagation in previous years, clones selected for this component of the project were successfully established in five field trials in China in early 2006. The same clones were previously evaluated extensively in Australia. Comparison of results (to be obtained next year) will provide information about the usefulness of data collected in both countries for predicting performance in the other.

5. To develop capability in YSRI and GIRO in application of molecular marker technology and sugarcane breeding.

As indicated in prior annual reports, molecular marker laboratories at both YSRI and GIRO have been developed with assistance from Australian staff in this project, with both micro-satellite (SIR) and ALP markers being run. Training of staff in China on in-situ hybridisation methodology also occurred in 2006.

FST/1999/095: Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: Genetics and silviculture

Bilateral

Overseas Collaborating Countries	China, Vietnam
Commissioned Organisation	State Forests of New South Wales, Tree Improvement, Australia
Project Leader	Mr Michael Henson Phone: 02 6650 5703 Fax: 02 6651 5027 Email: michaelhe@sf.nsw.gov.au
Collaborating Institutions	Guangxi Forest Research Institute, China China Eucalypt Research Centre, China Queensland Department of Primary Industries and Fisheries, Australia Hunan Provincial Forestry Department, China Chinese Academy of Forestry, China Forest Science Institute of Vietnam, Vietnam
Project Budget	$682,611
Project Duration	01/07/2005 to 30/06/2009
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Global demand for high-value hardwood timber is growing. There are two available sources of supply; native forests and plantations. Supply from native forests is under increased pressure, with less available areas for logging and a greater emphasis on conservation. This diminishing number of native forests has seen a rise in plantations of short-rotation hardwood species.

One of the limitations in growing short-rotation plantations is the difference in timber quality. Native forests take longer to mature, resulting in bigger and more robust log sizes that stand up to the stresses of sawing and processing. Plantation-derived logs have smaller diameters making them more prone to splitting, bending and curving during processing and sawing. Many plantations provide wood as a source of short fibre pulp and increasingly as a replacement for native forest products when this timber is in short supply.

In China, Vietnam and Australia an increased emphasis on conservation has contributed to reduced logging of native forests. This has increased the use of plantation timber in processing. Improving usability of this young timber depends on understanding the impacts of growth stresses on wood properties and how these contribute to problems in sawing and processing.

Such an understanding would help in guiding the choice of eucalypts suitable for short-rotation use and in the silvicultural management of these species.

This project aims to improve the economic returns to growers and processors from eucalypt plantations by developing and implementing silvicultural and genetic strategies to improve wood properties and thus optimise yields of high-quality timber from eucalypt plantations in China, Vietnam and Australia.

Project Progress

Year 2 (01/07/2006–30/06/2007)

The 2006–2007 financial year saw the project complete several major wood quality assessments in key trials in all partner countries (China, Vietnam and Australia). Silvicultural and genetic trials across a range of *Eucalyptus* species have been assessed for a range of wood properties. Harvested logs with known wood properties from all of these trials were provided to FST/2001/021 for a range of sawing, veneer and drying trials.

Results of the genetic and silvicultural traits of wood properties are still being analysed as well as the evaluation of a range of non-destructive assessment techniques.

Wood quality assessments were completed on the following trials as part of the project:

Australia:

- Eucalyptus nitens Provenance Trial (17 years)
- Eucalyptus pilularis Progeny Trial (9 years)

Vietnam:

- Eucalyptus urophylla Progeny Trial (10 years)
- Eucalyptus pellita Progeny Trial Vietnam – pilodyn only (6 years)

China:

- Eucalyptus urophylla x grandis Spacing and Fertiliser Trial (13 years)
- Eucalyptus Hybrid Clone Trial (15 years)

Preliminary results of the studies have been presented at conferences and workshops in China and Australia, and it is hoped that many of the results will be published in peer reviewed journals.

Results from an assessment of a spacing fertiliser trial in Guangxi southern China suggested that variations in establishment spacing resulted in major diameter differences with minimal impact on the fundamental wood properties.

A plan for additional work was prepared for the Hunan Forestry Department (one of the Chinese project partners) in December 2006, and the Hunan team have received additional provincial funding to enable them to complete the work plan. This will allow Hunan to establish and assess additional species, genetic and silvicultural trials over the life time of the project.

With the majority of the large wood quality assessments now complete the project is now moving in to a phase of analysis, modelling and evaluation of the economics of the results working in close collaboration with the team of FST/2001/021 in the three countries.

Training was provided to both Vietnamese and Chinese collaborators “in-country” in the use of standing tree and log assessment techniques to evaluate wood property. In both countries there has been considerable uptake of these methods, where in China several MSc theses have been completed utilising equipment and methods provided by ACIAR.

With co-funding from ATSE Crawford Fund two Chinese and one Vietnamese collaborator attended the inaugural Australasian Forests Genetic Conference in Hobart, Tasmania where several papers were presented on work associated with project FST/1999/096. After the conference the three delegates attended a course on using the statistical package ASREML for the analysis of genetic trials.

This was followed by a week’s course in non-destructive assessment of standing tree wood quality in northern NSW hosted by Forests NSW and Southern Cross University.

FST/2001/021: Improving the value chain for plantation-grown eucalypt sawn wood in China, Vietnam and Australia: sawing and drying

Bilateral

Overseas Collaborating Countries	China, Vietnam
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Dr Russell Washusen Phone: 03 9545 2173 Email: russell.washusen@ensisjv.com
Collaborating Institutions	Forest Science Institute of Vietnam, Vietnam China Eucalypt Research Centre, China
Project Budget	$519,932
Project Duration	01/07/2005 to 30/06/2009
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Traditional wood processing industries have utilised native forests for timber. As a result the industries in China and Vietnam, as elsewhere, have evolved processes for wood sawing that match the timbers used.

Increasing demand for timber has placed the burden of production on native forests, many of which are now in decline. Harvest restrictions are now being applied in China and Vietnam, limiting timber production from native forests. With these restrictions have come pressures on employment and a greater reliance on timber importation, creating trade imbalances.

A solution is planting eucalypts, together with other species as part of reforestation programs. Eucalypts primarily supply raw material for large industries: pulp and paper, fibreboard and chipping. Small-scale use in traditional industries is also undertaken, such as for furniture and joinery. Mainly small diameter logs (less than 30 cm) are used, but growth stresses are released when these are sawn using traditional approaches, splitting logs and rending them useless. Such constraints plus the tendency of plantation-grown eucalypt wood to distort have discouraged use.

The aim of this research is to:

- improve the efficiency of processing of small diameter plantation-grown eucalypt logs for solid wood products
- increase returns to plantation growers
- assist in the development of viable rural industries in China, Vietnam and Australia.

Project Progress

Year 2 (01/07/2006–30/06/2007)

Project FST/2001/021 continued to develop joint activities with FST/1999/091, by conducting processing trials using plantation material assessed in the field by FST/1999/091. This also involved engagement of industry in China, Vietnam and Australia. Major contributors were N. F. McDonnell & Sons (Victoria), Forest Enterprises Australia, the Dongmen veneer factory (China), Pisico (Vietnam), Raute (Singapore) and Veisto Oy (Finland). During the reporting period preparations were made for three processing trials (one each in China, Vietnam and Australia), and three others (one in China and two in Australia) commenced or were completed.

A report on the first of the processing trials has been completed. This was a sawing trial with ~135 logs conducted in collaboration with Forests NSW and N.F. McDonnell & Sons in Victoria using four provenances of *Eucalyptus nitens* (17-year-old plantations located near Tumut NSW) with measured peripheral growth strain levels, acoustic wave velocity (AWV) and Pilodyn measurements. The aim was to assess the capacity for these measurements to predict log and sawn board behaviour during harvest log handling and sawing. Sawing was conducted with a HewSaw R250, a single pass sawing machine developed by the Viesto Group in Finland that applies chippers and saws more-or-less simultaneously. The chippers which profile the cants appear to remove sufficient high stressed wood to allow sawing to proceed with little difficulty.

The major findings from this research were that growth strain was only moderately useful in predicting growth stress related log and board behaviour, AWV was found to be a good predictor of log and board end splitting and could be used to predict recovery of sawn boards after docking end splits. Bow in sawn boards was the only important board behaviour characteristic related to growth stress release during sawing. Generally, this was of limited extent and not sufficiently severe to prevent major problems during transport and stacking of the boards. There was some provenance variation detected in log and board end-splitting and bow in sawn boards suggesting some potential improvement in performance.

A second report has been prepared for a trial conducted at the Dongmen Forest Farm, Guangxi Province, China. This trial was a departure from proposed work because adequate sawing equipment could not be located in this region of China. To overcome this difficulty logs were peeled, then the peeled veneer sheets kiln-dried using standard processing methods for the production of internal grade veneer at the veneer factory in Dongmen. The trial used ~160 logs from a single clone of 12-year-old *E. urophylla* x *grandis* from a spacing trial located in the Dongmen Forest Farm, testing six spacing treatments. Growth strain, AWV and a number of other standing tree measurements were assessed for their potential to predict veneer recovery and quality.

The main findings were that growth strain was a moderate predictor of log-end splitting. On this occasion AWV was not a significant predictor of log end splitting. There was a significant effect detected for spacing treatment on recovery and value of veneer that was related to diameter growth. Models were developed that could predict recovery and product value based on log external features that could be used to value logs. Simulations suggest that there are likely to be substantial improvements in product quality with pruning as branch related defects were clearly the major grade limiting factor. Even greater improvement in product quality and value may be achieved with the production of appearance grade veneer.

In addition to pruning trees a number of changes to processing methods would be required such as the application of pre-heating of logs, conveyors to transport veneer, and restraint in driers to prevent buckling and splitting of veneer. Log-end splitting may also need to be reduced if appearance grade veneer were produced, however, this was not specifically tested in this research.

A third trial conducted with the HewSaw R200 at the FEA sawmill in Tasmania with ~480 logs from a Forests NSW *E. pilularis* family trial (10-year-old plantations located near Port Macquarie, NSW) is complete. A subset of ~160 logs was intensively measured to examine log and board behaviour as for the *E. nitens* trial above, so that comparisons can be made between trials. Product quality and value, board shrinkage and major grade limiting defects have been recorded for all logs. Financial modelling of the processing will be conducted using the financial analysis methodology in CSIROMILL, based around a module developed specifically for the HewSaw R200. Veisto Oy in Finland has been engaged to assist with input data to develop this module of CSIROMILL.

A processing trial is currently being planned for thinned 11-year-old *E. urophylla* from a family trial at Ba Vi in northern Vietnam. This will be conducted at the Pisico sawmill at Quy Nhon in central Vietnam. Sawing will be undertaken with a horizontal band saw followed by application of sheltered air drying, steam reconditioning and kiln drying. This trial will apply standard sawing patterns for teak and a modified cutting pattern to assess the potential to reduce board end splitting.

This project will also be conducted jointly with another funded by MARD to compare a number of drying strategies for *E. urophylla* from central Vietnam. As with the completed processing trials, growth strain and AWV from standing trees or logs will also be assessed for their potential to predict log and board behavioural characteristics with growth stress release. One processing trial in Lizhou, China using ~16-year-old *E. dunnii* and one at the FEA mill in Tasmania with CCV from Queensland are currently being planned. Assessment of the SilviScan technology in application for improvement in eucalypt resources for solid wood processing end-uses has also been completed and a report submitted to ACIAR.

FST/2001/086: Assessment of the potential of *Pinus radiata* for ecological restoration of the Yangtze River catchment in Aba Prefecture, Sichuan, China

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	State Forests of New South Wales, Forest Research and Development Division, Australia
Project Leader	Dr Hui-quan Bi Phone: 02 9872 0168 Fax: 02 9871 6941 Email: huiquanb@sf.nsw.gov.au
Collaborating Institutions	Chinese Academy of Forestry, China Sichuan Forestry Academy, China Aba Forest Research Institute, China
Project Budget	$150,090
Project Duration	01/07/2002 to 30/06/2007 (Project extended from 01/07/2004 to 30/06/2007)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Severe erosion has contributed to massive flooding and excessive sedimentation on a number of catchments in China, particularly the upper catchment of the Yangtze River in Sichuan. Due to the extreme site degradation and the harsh, dry climate of much of the upper Yangtze catchment re-establishment of the natural forest and native species has been problematic, and the Chinese have tested a range of exotic tree species for their suitability as protection forests. *Pinus radiata*, a conifer widely used in Australia in commercial plantation, holds promise.

This project is deploying Australian expertise, in collaboration with Chinese scientists, to aid the introduction and testing of a better range of *P. radiata* germplasm in the Yangtze catchment. The biological risks of establishing the species in such a new environment are being assessed as is developing nursery, field and data management technologies to support the large expansion of plantings planned for *P. radiata.*

Project Progress

Year 4 (01/07/2005–30/06/2006)

1. Assess the forest health risks to the long term success of *P. radiata* introduction in Aba.

After the field inspections and assessments in 2004–2005 by both Australian and Chinese forest entomologists and pathologists, a forest health monitoring program was put in place as a part of continuing evaluation of forest health risks to the long-term success of *P. radiata* introduction. Over the 2005–2006 reporting period, forest health survey and assessments were conducted twice for the widely separated small plantations established for environmental purposes. Presence of pest and pathogen species and their levels of infestation were recorded to evaluate the gradual loading of indigenous pests and diseases onto the newly introduced exotic species and to detect earlier signs of a pest and disease attack.

At the same time, the forest health literature on *P. radiata* and other *Pinus* species in China has been reviewed to identify both indigenous and exotic pathogens and pests that pose a potential threat to the long-term success of *P. radiata* introduction. The full text of scientific papers, published and unpublished reports from various sources was read to extract relevant information.

Historical records of pest and disease outbreaks in the coniferous forests of Aba prefecture and that of past forest health surveys in the area were examined in relation to the project objectives. Some specific information was also gathered from personal communications with other forest health experts. This broad forest health literature and information review provided a comprehensive understanding of the global and local forest health environment for the introduced *P. radiata* and served as a good basis for the assessment of forest health risks to the long term success of the species introduction in the dry river valley area.

The forest health information from the comprehensive review, field surveys and inspections in 2004/2005 and subsequent forest health monitoring were evaluated and analysed to produce a list of indigenous and exotic pathogens and pests that pose a potential threat to the long term success of *P. radiata* introduction in the dry river valley area. For each pathogen or pest on the list the likelihood of an attack and the impact of the possible attack over the foreseeable future were rated as low, medium or high based on the best available information and expert knowledge. Where both the likelihood of an attack and its impact are uncertain, it was marked as a gap of information to be filled by future investigations. A report on forest health risks to the long term success of *Pinus radiata* introduction in the dry river valley area is being prepared.

2. Integrate site, climatic information and knowledge on growth performances elsewhere in the world through climate modelling to identify suitable areas for environmental plantings of *P. radiata,* in southwest China in general and in the dry river valley area in particular.

Our work on climate modelling has resulted in a scientific paper being accepted for publication in the international journal, *Forest Ecology and Management*. This paper describes a new climatic profile for *P. radiata* that identifies summer rainfall areas in southwest China where the species may be suitable for environmental planting on degraded lands to reduce soil erosion.

The new climatic profile delineates the climatic requirements of *P. radiata* through six climatic factors. It includes the absolute minimum temperature as a measure of frost risk in the continental climatic environment and also has lower temperature and rainfall limits than profiles previously developed for commercial plantations.

Digital elevation models are developed at both regional and national scales to provide a surrogate of the three-dimensional geographic space of the target area for the spatial interpolation of climatic data. Areas with climatic conditions that match the new climatic profile are mapped using ArcInfo GIS. A chi-square statistic is used to evaluate the influence of each climate variable in the profile in determining the spatial limit of the mapped area. At the national scale, a climatically suitable area of more than 266 000 km^2 across three provinces in southwest China is identified. Mean maximum temperature of the hottest month and the length of dry season appear to be the major factors limiting the spatial extent of matched areas at this broad scale.

The results of climate matching for the Minjiang dry valley area in particular correspond well with the growth performance of experimental plantings in the field. At this regional scale, mean annual precipitation and mean minimum temperature of the coldest month are the major factors constraining the spatial extent of climatically suitable areas. The mapped areas can help define the working limits and serve as indicative zones for environmental plantings of *P. radiata* aimed at reducing soil erosion in southwest China. They will also enhance our understanding of the fundamental climatic niche and the potential geographical range of *P. radiata*.

3. Establish a provenance experiment to systematically evaluate provenance performances over different sites in Aba.

Following the successful establishment of the provenance experiment over three sites in 2004–2005, the maintenance of the three experimental sites became the major task over the reporting period of 2005–2006. Silvicultural treatments to control weeds and aid the early establishment of the planted seedlings were applied twice a year to each site. The survival and growth of seedlings were assessed in late 2005. Individual seedlings were coded, tagged and mapped for all three experimental sites over a period of three months. The experimental sites were inspected at least twice a year to detect potential pest and disease problems as a part of the forest health monitoring program. In addition, a temporary guarding station was set up to protect the experimental site at Mao Xiao from animal browsing.

4. Provide training to improve nursery techniques, methods of mycorrhiza inoculation, forest health assessment and stand management skills.

This project component was successfully completed during the last reporting period. No significant project activities took place over the reporting period of 2005–2006.

5. Develop and transfer technology such as database systems that are routinely used in Australia.

Not enough forest growth and experimental data have been accumulated for *Pinus radiata* to warrant the development of a database up till now. So no significant project activities have taken place over the reporting period of 2005–2006.

HORT/1999/081: Reducing spoilage and contamination risks of fresh vegetables in China and Australia

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	Department of Primary Industries, Victoria, Institute for Horticultural Development
Project Leader	Dr Robert Holmes Phone: 03 92109222 Fax: 03 98003521 Email: robert.holmes@dpi.vic.gov.au
Collaborating Institutions	Food Science Australia, Australia Institute of Vegetables and Flowers, China China Agricultural University, China China National Green Food Industry Company, China
Project Budget	$717,775
Project Duration	01/07/2004 to 30/06/2009 (Project extended from 01/07/2007 to 30/06/2009)
ACIAR Research Program Manager	Mr Les Baxter

Project background and objectives

Population growth in China and the expansion of urbanisation have increased pressures on vegetable growers to meet demand. Peri-urban vegetable production has been promoted as a means of increasing the availability and diversity of fresh vegetables in the growing urban centres. Spoilage of vegetables remains a problem, being caused by a range of factors. Peri-urban vegetable production systems are land and pesticide intensive. Competition for land and other inputs is at a premium, resulting in pressures on production, handling and marketing systems.

High postharvest losses caused by fungal and bacterial pathogens are common. Inadequate washing, grading and packing facilities contribute to this, as does limited options for disposing of wash-water and waste. Limited fresh water, and water and sewage pollution from inadequate infrastructure, result in poor quality irrigation inputs, sometimes utilising raw sewage. These also contribute further to pollution as they enter water courses as run-off. Vegetables are also often washed in these same water sources prior to sale.

Advances in the detection and monitoring of risk factors have been developed for vegetables, using polymerase chain reaction (PCR) technologies. These are applicable to monitoring of both vegetables and wash-water. Such technologies can also be used throughout the supply chain to detect human pathogen transmission risk factors. Much is known about the range of risk factors, how to prevent these spreading and how to improve systems management, inputs and monitoring. Some of this has been developed for Australian systems but is also applicable to China.

The project is analysing production and handling systems to determine risk factors leading to spoilage and contamination. Researchers are developing efficient strategies for decontaminating wash-water, and introducing hygienic postharvest washing systems for vegetables and improved monitoring of human pathogen contamination risks during fresh vegetable handling and marketing.

Project Progress

Year 3 (01/07/2006–30/06/2007)

1. Analysis of production and postharvest systems to determine risk factors leading to spoilage and contamination and development of recommendations for risk management.

Department of Primary Industries Victoria (DPIV) investigated the influence of the irrigation water source on postharvest quality of iceberg lettuce, cos lettuce and broccoli. Vegetables irrigated with river water, reclaimed water and a mixture of the two ('shandy') were assessed for harvested yield and quality retention after storage and simulated marketing. There was a trend of reduced yield in both recycled and shandy treatments, although yield reduction was only significant in iceberg lettuce irrigated with recycled water. Following storage, quality and storage life were similar in all treatments, however, lettuce irrigated with river water developed more severe rot. It is thought that this lettuce, which was higher yielding, was more susceptible to disease.

Vegetables were examined for pathogen indicators (thermotolerant coliforms, *Escherichia coli, Enterococcus* spp., *Clostridium perfringens*, *and Salmonella* spp.). Out of 85 vegetable samples, five samples (one river, three shandy, one recycled) had detectable levels of one or more indicators.

DPIV has been investigating the persistence of *E. coli* and enterococci on vegetables after harvest. In Year 3, experiments were conducted on lettuce, tomato and carrot stored at 4, 21 and 37°C, for 3 weeks. On carrot, populations of both pathogens declined steadily over time at all temperatures. On tomato, however, populations of both pathogens changed little over 21 days. On both tomatoes and lettuce enterococci were more persistent than *E. coli* at high temperature, suggesting enterococci would be a better indicator on these vegetables. DPIV also investigated the influence of mechanical damage in the field on the establishment and persistence of *E. coli* on lettuce heads after harvest. Lettuce plants were injured to simulate chewing insect damage at several intervals prior to inoculation with *E. coli*. Plants were watered with a mixture of *E. coli* strains. Watering with contaminated water within two days following injury or within five days of harvest was shown to be high risk.

China Agricultural University (CAU) completed a comprehensive microbiological contamination audit of fresh vegetables (54 samples of six vegetables from two farms, preharvest, after preparation for market and at retail). The six vegetables were cucumber, green pepper, radish, celery, lettuce and purple cabbage, all of which could be consumed fresh. Counts were made of total aerobic, yeasts and moulds, total coliforms, and *Enterococcus* spp. especially *Enterococcus faecalis*.

Total aerobic counts were higher on vegetables after trimming and preparation and from retail shelves than before harvest. The increase was attributed to workers' hygiene and the transfer of soil onto the leaves during trimming. The washing process was also not thorough. At retail, vegetables were at room temperature, which may have encouraged microbial growth. *Enterococcus* was found on cucumber, lettuce and purple cabbage sampled preharvest, after handling and from retail, and green pepper sampled after handling and from retail. *Enterococcus faecalis* was found on cucumber pre-harvest.

2. Development and testing of strategies for decontaminating wash-water and introduction of hygienic postharvest systems for vegetables.

Scientists from the Institute of Vegetables and Flowers completed experiments to investigate the influence of washing and sanitising on rot development of tomato. Experiments investigated the impact of washing method, sanitiser type and contact time on the incidence and severity of rot. Sodium hypochlorite (NaOCl) was shown to be the best sanitiser for tomato. The optimal treatment was soaking for 1 minute in 100 ppm NaOCl at 35°C. Tomatoes treated this way developed less than 10% rot following 7 days storage at ambient temperature.

3. Improved monitoring of human pathogen contamination risks during fresh vegetable handling and marketing.

In order to validate a PCR test for the identification of *E. faecalis*, Food Science Australia (FSA) scientists isolated 110 wild-type putative enterococci cultures from fresh vegetable, soil and irrigation water samples and identified the species using the API biochemical tests (bioMerieux). A total of 58 of these wild-type enterococci cultures have been tested using the multiplex *E. faecalis*/enterococci species PCR system developed in this project.

Experiments are also in progress using the most probable number (MPN) technique in combination with the multiplex PCR for determination of detection sensitivity on naturally existing enterococci, and challenged 5-strain enterococci mix in fresh vegetable samples. The method successfully detected *Enterococcus* spp. and *E. faecalis* inoculated at 10–100 cfu/g in fresh salad vegetables.

4. Development of technical capacities for hygienic handling of fresh vegetables and human pathogen contaminant monitoring.

Mr Zhang Xuejie (IVF) visited Australia in February 2007 to participate in experiments and attend a project planning and review meeting. Mr Zhang learned hygiene assessment techniques in studies conducted on harvest containers and packing lines. At FSA he trained in PCR techniques with the project team. Project staff attended three technical conferences to improve their knowledge.

ADP/1998/128: Achieving food security in China - implications of WTO accession

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	Australian National University, Asia Pacific School of Economics and Government, Australia
Project Leader	Dr Chen Chunlai Phone: +61 2 6125 6565 Fax: +61 2 6125 5555 Email: chunlai.chen@anu.edu.au
Collaborating Institutions	China Center for Economic Research, China Center for Chinese Agricultural Policy, China
Project Budget	$833,992
Project Duration	01/07/2000 to 30/09/2006 (Project extended from 01/07/2003 to 30/09/2006)
ACIAR Research Program Manager	Dr Ray Trewin

Project background and objectives

Since gaining WTO accession China has begun to liberalise its agricultural trade. In the short term, the impact will be limited. However, global trade liberalisation is likely to increase in the future. Whatever policies the country chooses to adopt in response, there will be changes to the economy – including effects on rural incomes and food security. The Chinese government will therefore need to set up policies to assist disadvantaged groups and help with a smooth transition. The choice of food policy in China will not only have a significant impact on the country's own economic structure, but will also help shape the pattern of world food trade and hence have important implications for major food-exporting countries such as Australia.

Joining the WTO came at a critical point in China's agricultural history. In the mid-1990s, domestic prices for major grain products, including rice, wheat and corn, rose rapidly towards (and even sometimes above) international prices. China could subsidise farmers and maintain prices for its own grains above international levels, or it could tax farmers (as in the past) by forcing its prices below world prices, or it could opt to open its markets to world trade.

The impact of these Government decisions will determine whether internationalisation of the food economy would destabilise the domestic food market; whether the country could earn enough foreign exchange if it had to import grain; and whether freer trade in food would prevent further increases to farmers' incomes and so widen the already large rural–urban gap in the country.

This project studied the implications of China internationalising its food economy, analysed the effect on the country's food policies of China joining the World Trade Organisation (WTO), and devised a set of policies to help improve China's food security.

Project outcomes

A general equilibrium model of the *Chinese economy with regional dimensions* (CERD) was developed that included the eastern coastal, central and western regions. The model described five agricultural sectors and 39 non-agricultural sectors and distinguished between rural and urban households.

The modelling analysis found that regional income disparity, which has been worsening since 1991 will be reinforced rather than eased by the WTO accession. The eastern coastal region will have much higher gains than the inland regions. The analysis also revealed that the rural–urban inequality will worsen in all regions.

A new version of CERD with disaggregated agricultural sectors predicted that agricultural sectors would be adversely affected by the WTO accession: agricultural output would fall, grain and total food self-sufficiency rates would decline. However, the magnitudes of the impacts were determined to be smaller than initially anticipated.

It was consistently shown that the trade reforms China adopted in order to accede to the WTO will mean substantial structural changes within the agricultural sector. The reforms would seem to result in substantial negative impacts across the sector and a worsening of food security in the sense of reduced access to income. However, it cannot be stated too strongly that the outcomes of the reform have to be analysed from an economy-wide perspective.

In China, as in other rural-based countries, the main factors behind reductions in rural poverty will be the scope for rural households to earn off-farm income and for people to move from rural areas into industrial and services activities in urban centres. Therefore, to a very large extent, the success of the trade reforms will depend upon policies outside of agriculture.

The modelling has also shown that China's monetary policy regime of the fixed *yuan* and capital controls has increased the rural-urban income gap by raising real wages and reducing employment growth in the non-agricultural sectors. Moving away from this monetary policy regime could lead to a much more rapid relocation of labour out of agriculture and thereby promote a reduction in the rural-urban income gap.

The study found that the entry into the WTO has boosted China's trade in agriculture, especially its agricultural imports. China has had two consecutive years of trade deficit in agricultural trade since 2004. The country has no comparative advantage in land-intensive agricultural production and, as found in the study, the comparative advantage indices of these agricultural products have been speedily declining since China's entry into the WTO.

The pattern of China's agricultural trade is consistent with the country's comparative advantage and resource endowments. After the entry into the WTO, this pattern has been strengthened, indicating that China is moving closer to its comparative advantage in agricultural trade with the rest of the world.

The research team studied what economic effects the China-ASEAN Free Trade Area (CAFTA) will have as it is established in two stages before 2010. The study predicted that CAFTA will increase social welfare and promote real GDP in both economies. There will be a large trade creation effect among the CAFTA members, and their total exports will increase during the implementation phase. However, there may be a trade diversion effect as trade between members and other regions decline after CAFTA's creation. But as a whole, total world trade will increase, especially in the second stage of the full implementation of CAFTA.

The integration of the Chinese and ASEAN economies also provides opportunities for other agricultural exporting countries to increase their trade to both markets. These will come in agricultural commodities for which neither China nor ASEAN have a comparative advantage – such as cereals, milk, beef and raw materials.

HORT/1998/140: Postharvest handling and disease control in melons in China and Australia

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	University of Sydney, Australia
Project Leader	Dr Robyn McConchie Phone: 02 9351 4332 Fax: 02 9351 4172 Email: r.mcconchie@usyd.edu.au
Collaborating Institutions	China Agricultural University, China Sydney Postharvest Laboratory, Australia Gansu Agricultural University, China Xinjiang Department of Agriculture, China University of Queensland, Australia Xinjiang Agricultural University, China
Project Budget	$966,252
Project Duration	01/01/2002 to 30/06/2007 (Project extended from 01/07/2005 to 30/06/2007)
ACIAR Research Program Manager	Mr Les Baxter

Project background and objectives

Melons are one of the most important cash crops grown in the northern-central and north-west provinces of China, accounting for a large percentage of many farmers' incomes. Cultivation of melons in the Xinjiang and Gansu provinces increased from 247,570 ha in 1995 to 311,500 ha in 1998, while the tonnage grew from 5 million to just over 6.5 million.

The main markets for melons, however, are not local, but are in the eastern coast cities such as Beijing, Shanghai and Guangzhou, some 1500 km away. In China, little has been done to control postharvest diseases or maintain melon quality, so very high losses (35-50 per cent) have been recorded, particularly when melons are sent over these long distances. Consequently, prevention of postharvest disease and maintenance of melon quality during transport has become a major problem for the farmers and wholesalers.

Past ACIAR-supported research of postharvest melon handling systems in China identified the major agents responsible for losses; cultivar susceptibility to disease, rough handling after harvest, inadequate packaging and temperature management, and long transport times. This also showed that significant control of postharvest diseases of melons in China was possible.

With continuing pressure for the withdrawal of postharvest fungicides (benomyl is already withdrawn) and ongoing problems with quality maintenance, new options are needed. A range of novel treatments, including fungicides and chemicals which boost the natural defence mechanisms in plants, may help.

In the earlier ACIAR project, shelf-life of the rockmelons was extended to three weeks, which would enable them to be exported to the Hong Kong and Singapore markets by sea-freight. However, further work is required to assess the efficacy compounds that elicit systemic resistance in melons, and to fine-tune application strategies in relation to environmental stressors such as heat- or water-stress.

This project examined these factors to improve postharvest disease control, handling and market quality of melons and other cucurbits, and improve returns to growers in China and Australia.

Project outcomes

This project is in the final extension phase of a 3-year project that focused on: a) extension and promotion of the research outcomes to improve postharvest handling and disease control of melons in China and Australia, b) building a demonstration cool store in Gansu province, and c) continuation of research into safer methods of pre- and postharvest disease control in cucurbits.

A demonstration cool store was built at Sho Cheng during the first half of 2006, and is for use by members of the Farmers Cooperative in the district. The building was designed by Dr Steve Morris and built using locally sourced materials. The evaporative cooler was shipped from Australia. The cool store was officially opened by the Mayor of Sho Cheng with Dr McConchie and Dr Wei present.

To promote better communication between farmers and the Department of Agriculture, Dr McConchie and Dr Wei held a workshop for 80 Minqin County extension officers in Gansu Province, on methods and practice in participatory extension. Evaluation of the workshops indicated that these extension techniques were new to the participants and were very well received.

At Sho Cheng in Gansu Province Dr McConchie and Dr Wei presented an extension workshop with 50 farmers on melon handling, product quality control, improving access to markets and food safety.

In Xinjiang Province the team travelled to Lukeching near Shan Shan where we held an all day workshop with farmers to support implementation of cool store and cool chain technologies and to help develop aims and objectives for new project funded from Chinese sources.

At the University of Sydney research into use of induced resistance to control postharvest diseases continued. Two antifungal compounds were isolated from melon fruit and are currently being identified. A new technique of applying BTH via seed treatment to avoid phytotoxicity symptoms appears to be promising. New funding has been sought to continue with this research.

HORT/2002/016: Improving the implementation of integrated crop management in Brassica vegetables through a decision support toolkit based on end-user needs in China and Australia

Bilateral

Overseas Collaborating Countries	China
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Extension, Australia
Project Leader	Ms Bronwyn Walsh Phone: 07 5466 2222 Email: bronwyn.walsh@dpi.qld.gov.au
Collaborating Institutions	University of Queensland, Centre for Biological Information Technology, Australia Zhejiang University, Department of Plant Protection, China Zhejiang Department of Agriculture, Zhejiang General Plant Protection Station, China
Project Budget	$398,771
Project Duration	01/07/2003 to 31/10/2006 (Project extended from 01/01/2006 to 31/10/2006)
ACIAR Research Program Manager	Mr Les Baxter

Project background and objectives

In China, brassica vegetables account for about 50 per cent of total vegetable production and consumption. Tropical and sub-tropical brassicas are particularly susceptible to pests and diseases, many of which could be controlled through integrated crop management (ICM). But it is harder to get farmers to use ICM than chemical sprays. Compared to calendar-spraying with chemicals, ICM involves the farmer in more complex decision-making.

An added difficulty is accessing information on good ICM practices. In China there is a lack of experienced decision makers and decision-support tools. And in both China and Australia information is not prepared in suitable formats that cross disciplines, relate to problem-solving or meet the actual rather than perceived needs of decision-makers.

Fortunately, good ICM practices have been developed (especially through ACIAR projects) and it is increasingly urgent to implement them – to deal with resistance of pests to chemicals, residues in produce, and the increased management costs and health problems for those using the sprays. This project sought to convince farmers of the merits of adopting the more sustainable practices of ICM, and using them well.

The objectives of the project were to:

- identify the key constraints to ICM implementation amongst decision-makers, and clarify where information can address these constraints (in both China and Australia)
- overcome adoption constraints by developing information tools such as diagnostic keys and ‘best practice’ management options - developed in both Mandarin and English
- field-test the prototype information tools
- make a detailed evaluation of the impact, i.e. the extent to which the tools improved practical implementation of ICM.

Project outcomes

The key outputs of the project were toolkit prototypes in Mandarin and English, designed to meet the respective information needs of the Chinese and Australian brassica industry members in addressing integrated crop management constraints.

In China, the toolkit consists of CD based decision-support tools and training multimedia system plus a paper-based field guide to integrated management of vegetable brassicas. The CD is divided into seven subsystems - crop cultivation, fact sheets, pesticides, diagnosis and identification, pesticide application, glossary and other information. One thousand copies were published and distributed in Zhejiang Province.

The paper-based field guide offers concise descriptions and practical reference for identification of brassica pests, diseases and disorders, with 221 high-resolution photos to assist in field identification. Apart from offering background information and general management strategies for individual pests and diseases, the field guide presents management protocols for individual crops through a season, especially the strategic application of pesticides. One thousand copies of the field guide were distributed to farmers from the 10 major vegetable production areas in Zhejiang. In each locality, 60–70 farmers attended a half-day training activity. A further 200 copies were sent to extension officers in Shanghai, Jiangsu, Anhui, Fujian, Yunnan, Guangdong, Hunan, Hubei, Sichuan and Chongqing, and to the National Extension and Service Centre in Beijing.

In Australia, the English toolkit prototype is presented on a CD which contains tools to correctly diagnose and evaluate problems in brassica vegetable crops.

Other support material comprises 326 fact sheets, over 900 images and three games, together with links to State, National and International websites. An index, glossary and tutorial for using the diagnostic key maximises the users' experience of the toolkit. A strategy to develop the prototype for release to the Australian industry has also been produced as part of the project and will mean release of the Australian toolkit in June 2007. This will complement existing paper-based information tools in Australia.

Practical implications of the project were highlighted from the needs analyses. This demonstrated that information could help overcome some but not all the constraints to implementing integrated crop management practices, and that more than one format of information was required to meet all needs.

8 ACIAR Publications

This is a list of ACIAR publications produced in 2006-07. 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	
119a	Guidelines for surveillance for plant pests in Asia and the Pacific [Indonesian translation]. Teresa McMaugh, Indonesian translation by Andi Trisyono, 2007, 192 pp.
123a	Agricultural development and land policy in Vietnam [Vietnamese translation]. Sally P. Marsh, T. Gordon MacAuley and Pham Van Hung (eds), Vietnamese translation by Pham Van Hung, 2007, 272 pp.
124	Economically important sharks and rays of Indonesia. W.T. White, P.R. Last, J.D. Stevens, G.K. Yearsley, Fahmi and Dharmadi, 2006, 330 pp.
125	Aquaculture in Papua New Guinea: status of freshwater fish farming. Paul T. Smith (ed.), 2007, 123 pp.
126	Agricultural development and land policy in Vietnam: policy briefs. Sally P. Marsh, T. Gordon MacAulay and Pham Van Hung (eds), Vietnamese translation by P.V. Hung, 2007, 72 pp.
127	Postlarval fish capture and grow-out. Cathy Hair, Regon Warren, Ambo Tewaki and Ronnie Posalo, illustrated by Kisi Mae, 2007, 32 pp.

Proceedings	
122	Improving yield and economic viability of peanut production in Papua New Guinea and Australia. Rao C.N. Rachaputi, Graeme Wright, Lastus Kuniata and A. Ranakrishna (eds), 2006, 118 pp.
124	Heart rot and root rot in tropical Acacia plantations. Karina Potter, Anto Rimbawanto and Chris Beadle (eds), 2006, 92 pp.
125	Coconut revival: new possibilities for the 'tree of life'. S.W. Adkins, M. Foale and Y.M.S. Samosir (eds), 2006, 104 pp.

Technical Reports	
64	Towards improving profitability of teak in integrated smallholder farming systems in northern Laos. Stephen Midgley, Michael Blyth, Khamphone Mounlamai, Dao Midgley and Alan Brown, 2007, 96 pp.
65	A review of animal health research opportunities in Nusa Tenggara Timur and Nusa Tenggara Barat provinces, eastern Indonesia. Bruce M. Christie, 2007, 76 pp.
66	Modelling minimum residue thresholds for soil conservation benefits in tropical, semi-arid cropping systems. M.E. Probert, 2007, 36 pp.

Working Papers	
62	Report on a review of ACIAR-funded projects on Rhizobium during 1983–2004. David F. Herridge, 2006, 48 pp.
63	Economics and market analysis of the live reef-fish trade in the Asia–Pacific region. Brian Johnston (ed.), 2007, 172 pp.

Impact Assessment Series Reports	
44	Impact assessment of capacity building and training: assessment framework and two case studies. Jenny Gordon and Kevin Chadwick, 2007, 120 pp.
45	Development of sustainable forestry plantations in China: a review. John W. Turnbull, 2007, 78 pp.
46	Mite pests of honey bees in the Asia–Pacific region. Michael Monck and David Pearce, 2007, 32 pp.
47	Improved Australian tree species for Vietnam. Hayden Fisher and Jenny Gordon, 2007, 36 pp.
48	Assessment of capacity building: overcoming production constraints to sorghum in rainfed environments in India and Australia. Chloe Longmore, M. Cynthia Bantilan and Jenny Gordon, 2007, 44 pp.
49	Minimising impacts of fungal disease of eucalypts in South-East Asia. Hayden Fisher and Jenny Gordon, 2007, 36 pp.
50	Improved trade in mangoes from the Philippines, Thailand and Australia. Michael Monck and David Pearce, 2007, 48 pp.
51	Growing trees on salt-affected land. James Corbishley and David Pearce, 2007, 44 pp.

Corporate publications	
	ACIAR Annual Report 2005–06. October 2006
	ACIAR Annual Operational Plan 2007–08. June 2007
	Adoption of ACIAR project outputs: studies of projects completed in 2002–2003. J. Gordon and J. Davis (eds), 2007, 64 pp.
	ACIAR Publications Catalogue 2007
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ACIAR is an Australian Government Statutory Authority that operates within the portfolio of Foreign Affairs and Trade. ACIAR aims to enhance rural household incomes and broader economic growth by investing in international research partnerships that encourage agricultural development, sustainable use of natural resources and capacity-building of benefit to partner countries and Australia.

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