Country Profile

China

November 2005

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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Preface

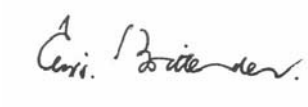
The ACIAR Country Profiles are designed to give a snapshot of the collaborative research being carried out between Australia and our various partner countries. This publication contains short summaries of bilateral and multilateral projects with China that were active from 1 July 2004 - 30 June 2005. At that time there were 25 active bilateral projects, and 5 active multilateral projects, the latter being led by international agricultural research centres. There were another 5 bilateral and 1 multilateral projects under development, many of which are expected to start in 2005-06 financial year.

This publication also sets out the key outputs and outcomes from 7 projects (6 bilateral and 1 multilateral) that have been completed from 1 July 2004 – 30 June 2005.

In addition to these project summaries, the publication includes an extract from ACIAR's 2004–05 Annual Report covering China, our near-term program as outlined in the 2005–06 Annual Operational Plan, and a record of the most recent consultations held between ACIAR and China on the medium-term priorities for the joint program.

ACIAR will update this profile each year and distribute 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.



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November 2005

China Report 2004–05

(extract from ACIAR Annual Report 2004–05)

Active projects in 2004–05	31
AOP budgeted expenditure in 2004–05	$3,910,000
Actual bilateral country expenditure in 2004–05	$3,926,454
Bilateral country expenditure in 2003–04	$4,231,678
Bilateral country expenditure in 2002–03	$3,951,287

Key performance indicators	Performance 2004–05
• Increased co-investment by Chinese Government in ACIAR projects	Chinese cash co-funding in two recently negotiated projects; $1.48 million, $0.61 million. Agreement by Chinese government to co-invest in agreed priority projects.
• Five Tibetan scientists trained in new ACIAR projects	Five Tibetan scientists trained in soil management and three in animal husbandry, supporting project implementation. First Tibet AR John Allwright fellow chosen.
• Agricultural sustainability a theme of at least two-thirds of projects	Of 9 projects developed or commenced, four have a strong focus on sustainability with three addressing aspects of sustainability.
• ACIAR projects implemented to contribute to more sustainable use of grasslands in Inner Mongolia and Gansu provinces	Project to change grasslands management through livestock farming system commences, including policy analysis at local, regional and national levels.
• Evidence of more efficient use of nitrogen fertilisers in the North China Plain	Independent impact assessment demonstrated significant adoption of simple practices to reduce gaseous losses of nitrogen fertiliser from maize crop in the North China Plain and savings from reduced wastage, as worth >$200 million.
• Continued spread of conservation tillage technology to eastern parts of Loess Plateau	Independent impact assessment revealed a total of 220,000 ha of maize and wheat cropping lands placed under conservation tillage collated across 13 north-western provinces of China. The projected benefit for wheat in China is $408 million.
• Demonstration of community benefits from development of eucalypt plantations in southern China	Independent impact assessment of eucalypt tree improvement estimated total eucalypt research effort in China (by ACIAR, AusAID and Chinese partners) generated a benefit of $1.3 billion, including benefits to many households in southern China.
• Molecular marker laboratories for sugarcane breeding established	Molecular marker laboratories established for sugarcane analysis in Guangzhou and Yunnan provinces.
• Improvement of product quality attributes and resistance to stripe rust in Sichuan wheats	Improved quality and disease resistance characteristics identified in breeding lines—release of varieties several years away.
• Fumigation recommendations revised and implemented in grain storage facilities across China	Recommendations for phosphine fumigation in modern storage facilities accepted nationally with ongoing training through State Administration of Grain.

Position

ACIAR's program in China has evolved with the growing Chinese economy. Initial project activities were in eastern China, but the focus has shifted to western China and now emphasis two broad issues—raising the incomes of poor smallholder farmers and enhancing and improving the sustainable management of China's natural resource base. The sustainability of agricultural production is being addressed through policy and technical projects relating to water, land and forest resource management in less developed regions of northwest and southwest China. The need to raise the incomes of poor farmers while addressing sustainability of increased productivity in crop, livestock and forestry systems is included in project design.

ACIAR has also initiated a small suite of projects in Tibet Autonomous Region, where activities are focusing on the need to improve crop rotations and livestock production through nutrition and animal management. Studies to improve grassland management are also in progress. Another facet of ACIAR activities is the increasing level of co-investment by Chinese Government institutions, due in part to the alignment of projects with China's highest research priority areas.

Achievements

A series of ACIAR projects is addressing sustainable **land and water resource management—a priority for Chinese agencies.**. Water management in irrigation schemes, of which China has many, is vital if the country is to continue to meet food demands. Helping managers in the Zhanghe basin scheme to balance competing water demand from agricultural, urban and industrial users has been the focus of two related projects. Farmers in the scheme assess their water need and then request irrigation authorities for water release via a series of canals, in return for a fee. A water management model operating in Vietnam has been adapted to better allocate water allotments in China. This operation, in combination with a revised fee structure, has seen lowered demand for water allowing systems management to be improved. China's National Centre for Irrigation and Drainage plans to promote these findings to other irrigation scheme managers. The associated project is assessing the impact of **farmer-level water-saving initiatives** promoted by irrigation authorities. This involves surveys of farmers in the Zhanghe basin and assessment of the impacts of farm-level savings on the water system. Several farmers have also been involved in trials of water-saving approaches and technologies for three crops.

Competition for water impacts on irrigation schemes at the broader inter-system level as institutions responsible for allocating scarce water resources deal with increasing demand. A framework to assist in policy development relating to water allocation is in production for **the Yellow River Basin**. A hydrological model covering a range of interactions, such as soil-water and soil-moisture balances is to be used to develop surface-water reallocation policies. Another water sustainability project is examining options to reuse wastewater. In Shanxi Province work has begun to develop innovative uses for the CSIRO-developed 'FILTER' technology and apply this to purify waste water on a commercial scale for cropping lands.

Other project research is dedicated to utilising much of the fragile land in China's north and west—the source of much of the windblown air-pollution in Beijing and north-eastern China. Introducing land-use changes in northwest provinces that will **promote sustainable farming and reduce land degradation** has been the aim of the Government's Grain for Green Program, an initiative to convert from cropping to forestry. The success of this and associated sub-programs is being assessed by a survey of the intended target group—farmers. These interactions are revealing the strengths and weaknesses in the program and identifying policy areas in need of refinement, such as land tenure.

The **Songnen and Yinchuan Plains of northern China** face a growing salinity threat. Researchers are building hydrological and hydrogeological conceptual models of these areas before they develop new irrigation and crop production approaches.. These are guiding experiments and field trials of alternative approaches and revealing potential options for their management.

Two projects are active on the Loess Plateau to improve the productivity of smallholders while reducing environmental impacts. Traditional methods had accelerated erosion but conservation tillage experiments at Dingxi and Xifeng have proven that **no-tillage systems** can produce crop yields comparable to those from conventional approaches (see box below for more information.

Revegetation of the hillsides on the Loess Plateau has been undertaken in recent times, and rates of erosion are dropping, but the impact this is having on water catchments is not clear. Models to examine broad-scale hydrology are under development to help determine future strategies for replanting activities, such as better matching locations to species selection.

Conservation tillage to control soil erosion

Soils on the Loess Plateau in China are not suited to traditional agricultural systems. The deep ploughing of soils and extended fallow periods between crops have exacerbated the widespread problem of erosion.

The Plateau's soil types, slope and rainfall have combined with these tillage practices to create one of the world's worst soil erosion problems. Dust storms that regularly hit Beijing (and as far afield as Korea and Japan) often begin in the Loess region.

Conservation tillage practices, trialled at two locations on the Plateau have reduced erosion. Seed is sown into the stubble left behind after harvesting the previous crop. There is no deep ploughing. Soil is not broken up and less labour is needed in crop planting.

The traditional fallow period over summer has been replaced too. Short-season legume crops such as soybean have been planted. Perennial lucerne forages are also being planted. Productivity in following crops has increased, in part due to these short-season legumes adding nitrogen into soils, thereby boosting their fertility.

The new practices worked in the project trials. But would farmers outside these trials adopt a system that contradicted their traditional ways?

Feng Jun, a farmer near one of the trials, answered the question when he approached the project team after seeing the impressive results. He and other farmers asked how they could get involved. On-farm trials of conservation tillage and crop rotations had been planned for the final stages of the project, not half-way through. But the opportunity to work with Mr Feng and others was too good to pass up, even if earlier than planned.

Some of the farmers involved in on-farm research trials are maintaining and even increasing yields under the new system. Mr Feng believes the system also offers other advantages, such as reduced labour. Watching how he and his fellow farmers are adapting to the new management approaches will help the research team to deliver its recommendations to Chinese extension agencies keen to expand the area under conservation tillage.

Many farmers in China's west, and in Tibet Autonomous Region, rely on grasslands to support livestock farming. The **sustainable management of grasslands in western China** is both a policy priority and the subject of ACIAR research. A new project is beginning to establish the avenues for increased production efficiency to allow farmers to graze fewer animals, resulting in better quality, increased production and higher prices. Another project is examining the role of forages in crop–livestock systems as a means of growing fodder to ease pressure on overgrazed grasslands. Trials are under way to identify suitable varieties for these grasslands as well as for saline and waterlogged soils in the Yellow River Delta and acid soils in China's south. Of 200 varieties tested 53 are now being multiplied at sites in China. This work is also linking into project activities in Laos to test lucerne varieties. **Rodent control techniques** have lacked refinement and often impact on non-target species. Monitoring of rodent and other small mammal populations is under way. Field trials using the information gathered have been initiated for sustainable controls of target species. This includes work to test immunocontraceptive vaccines that render target species infertile.

Another project aims to increase the productivity of **ruminants to meet demand for beef and milk** in Tibet Autonomous Region. Converting the benefits of pasture forages planted to stop erosion into improved beef production relies on the right choice of species. **Strategies for farmers producing livestock** in the Red Soils region, based on integrating quality forages, crop residues and by-products into feeding options, are under development. Species of forage grasses have been assessed for advantages offered in beef production—such as superior dry matter production, a greater leaf to stem

ratio and ease of harvesting and transporting. Decision-support systems will help quantify these and related findings. Many of these recommendations will assist policy development regarding incentives for farmers and through extension agencies give practical support for farmers changing to the new system. **Milk is central to farming and culture in Tibet AR** and, along with other milk products, is a staple food. With demand rising by 20 per cent a year, research to help smallholders increase production and tap into this market is under way. Researchers are adapting an approach similar to that used in the Red soils project above. An annual calendar of available feeds will assist smallholders.

China's recent **accession to the WTO is the subject of two projects**, designed to lessen the impacts of this transition on smallholders in the poorer western regions. The implications of national policy to support food self-sufficiency, particularly in the grains sector, are likely to create negative impacts on poorer farmers. Without some comparative production advantage based on labour and/or land these farmers will lose out as the income disparities between the wealthy east and the poorer west are heightened. Modelling of this scenario is now helping direct policy to create opportunities for poorer farmers to gain by establishing some comparative advantage. Surveys of farmers to assess current WTO accession-related impacts have also been undertaken as part of a separate project.

Another area of research is delivering improvements in postharvest management of vegetable and melons. Market demand for quality produce is rising. Smallholders, both in peri-urban areas and western China, are seeking to meet this demand. Two projects aim to introduce improvements in the market chain for melons and vegetables, including more suitable packaging and greater preharvest disease and quality control. Resistance elicitors that boost a plant's natural defences have proven promising **to stop disease in melons spreading postharvest**. When combined with fungicides this approach further reduces disease outbreaks. Contamination of vegetables by disease agents is often due to poor quality inputs such as water polluted by sewage that encourage the development of pathogens. Scientists are developing tests to detect their presence on vegetables.

A suite of projects is examining how to improve existing crops by utilising improved varieties. Genotype-by-environment trials to boost **wheat yields and quality in Sichuan province** are now complete, and analysis of data to determine yield constraints, occurrences of sterility and quality characteristics is under way. Work on **characterising the genetic makeup of Chinese sugarcane** continues. Up to 100 clones of varieties with suitable traits are being tested in China. Sugarcane seed is being exchanged between China and Australia for incorporation into breeding programs. Working with AQIS, a protocol for quarantining seed has also been developed for Australia. Two other projects are using germplasm exchange. One is determining suitable quality lines of **field peas and faba beans**, both important food legumes. Field trials and molecular studies are under way on lines exchanged between Australia and China. A similar project, involving India as well, has recently commenced for oilseed brassica improvement.

Improvement to brassica crop production is taking place through extension of past project results into a **successful Integrated Pest Management (IPM)** package, focusing on the needs of farmers in 10 locations in Zhejiang province. This will be presented in the form of a toolkit that provides farmers and extension workers with answers to questions about pests and useful information about IPM approaches.

A recent, independent economic assessment into the value of joint ACIAR, AusAID, and Chinese research in the eucalypt plantation industry in China has revealed a billion dollar payoff. The research, stretching back to 1981 with the China–Australia Afforestation project, is **expected to generate a net present value of $1.3 billion** over the 30-year period from 1985 to 2015. Work on selection of cold-tolerant species for the cooler regions of China has recently concluded. The information gathered on seed management and silvicultural aspects of plantation management, such as thinning and pruning is now helping as scientists introduce the cold-tolerant species identified in the project.

China Plan 2005–06

(extract from ACIAR Annual Operational Plan 2005–06)

GNI per capita[1]	AUD 1,696
Population[2]	1,275.2 million
Population 2025/2050[3]	1,445.1 / 1,395.2 million
Active bilateral projects	22
Active multilateral projects	2

Bilateral actual 2003–04*	$4.2m
Bilateral forecast 2004–05*	$3.9m
Bilateral budget 2005–06*	$3.7m
Multilateral budget 2005–06	$0.4m

*Includes AusAID-funded projects: $0.03m (actual 2003–04), $0.16m (forecast 2004–05), $0.1m (budget 2005–06); does not include co-funding of projects ($0.18m in 2004–05 and $0.4m in 2005–06) by GRDC and the Department of Environment and Heritage (Australian Greenhouse Office).

Medium-term strategy

ACIAR's program in China focuses on sustainability aspects of agricultural production through policy and technical projects on better management of resources such as water, land and forest in less-developed regions in northwestern and southwestern China. In addressing sustainable production, the need to raise farmers' incomes through increased productivity and quality of crops, livestock and forestry products is also taken into account in project design. Where appropriate, ACIAR will facilitate broader interactions between Chinese partner agencies and Australian agencies. ACIAR will make small investments that foster collaborative linkages between projects that have been funded from other Australian and Chinese sources. In recognition of the importance (and changing nature of) the relationship, funding for exchange visits for workshops or for exposure to Australian agricultural policies, natural resource management practices, institutions and research management may be provided.

Key performance indicators (2005–06)

- Significant co-investment by Chinese partners in all new projects
- New priorities for cooperation agreed at 2005 China–ACIAR country consultation
- Closer integration between teams working on ACIAR-funded projects with CGIAR centres (multilateral projects) and bilateral projects
- Policy options for improved allocation and management of water from the Yellow River communicated to and acknowledged by senior decision-makers
- Further adoption of alternative irrigation methods to reduce water use by rice growers in eastern China
- Initial assessment of regional impacts of revegetation on water resources of the Loess Plateau completed
- Initial trials on double cereal–legume cropping feasibility completed in relevant parts of the Tibet Autonomous Region
- 40% of new projects designed to have significant farmer or policy-maker impacts within 5 years of completion

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 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 wind-blown dust in Beijing.

[1] Source: Commonwealth of Australia, *Australia's Overseas Aid Program 2005–06*, Statement by Minister Alexander Downer, May 2005.
[2] Source: United Nations Population Division, 2004, *World Population to 2300*.
[3] Source: United Nations Population Division, 2003, *World Population Prospects: The 2002 Revision*.

The focus of ACIAR's program has shifted towards western China in line with the poverty-reduction emphasis of the Australian aid program. Important issues are the need to raise farmers' incomes, better management of scarce water resources, producing better quality agricultural products, and uptake of opportunities arising from previous research.

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 Australian development policy (poverty reduction in western China through institutional reform and environmentally sustainable rural development)
- Complement other schemes for China–Australia collaboration
- Be in areas where the overwhelming driver is Australian technical comparative advantage *rather* than provision of funding
- 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 and Chinese counterparts will conduct a consultation meeting in mid-2005, and it is possible that some new priority areas for cooperation, such as in food safety or animal health, will emerge. However, it is expected that the ACIAR program in 2005–06 will continue to emphasise benefits for resource-poor farmers in northwestern and southwestern China, including the Tibet Autonomous Region. In Tibet AR, activities will focus on the need to improve crop rotations and crop management, improved management of grasslands and improved livestock nutrition. An initial suite of four activities was put in place in 2003 and 2004. ACIAR and Chinese partners will monitor their implementation before committing to additional projects.

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 – Australia (DAFF) and the Chinese Ministry of Agriculture jointly administer the **Australia/China Agricultural Cooperation Agreement** (ACACA, www.affa.gov.au/acaca), which provides funding for agricultural-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. Over 160 projects have been completed since 1984.
- Australian Government Department of Education Science and Training, 'International Science Linkages program' (www.dest.gov.au/science/isl). This includes competitive grants under the **Australia–China Special Fund for S&T Cooperation**. The Australian Government will contribute up to $500,000 annually, and 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).
- DEST also support another scheme, the **Chinese Higher Education Strategic Initiative**, which aims to help promote education, training and research collaboration between Australian and Chinese universities. About half of the projects supported in 2003 were agriculture and agricultural policy research collaborations.

- AusIndustry manages a separate **'Innovation Access Programme—Industry'** (www.ausindustry.gov.au) which provides support for linkages between Australian and Chinese researchers in areas of commercial potential.
- Food Standards Australia and New Zealand and the Chinese Ministry of Science and Technology recently entered into a MoU 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 2005–06, DEH will 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 which will be of benefit to China.

Indicative priorities

ACIAR consults with partner countries to establish priorities for research collaboration. A formal country consultation meeting was held in October 1999. The full record is available at www.aciar.gov.au under Partner Country Priorities/China. Specific priorities from this consultation that relate to the current China program include:

Agricultural development policy and economics

- Agricultural policy studies on technology impact assessment
- Implications of WTO accession for agriculture and smallholders

Forestry

- Sustainable forest management in subtropical areas
- Rehabilitation of degraded forest ecosystems
- Effective reforestation technologies for key catchment areas in the Yangtze and Yellow Rivers, and in western desertified areas

Sustainable production systems

- Soil fertility improvement and efficient use of chemical fertilisers
- Soil chemical degradation related to nutrient and organic matter depletion, acidity and sodicity
- Crop residue management, including alternatives to burning
- Farm-scale water-saving technology and irrigation system management
- Development of productive and sustainable farming systems for arid regions

Program Adviser

Dr Ian Willett

Key program managers

Dr Ray Trewin, Agricultural Development Policy
Mr John Cullen, Crop Improvement and Management
Dr Russell Haines, Forestry
Dr Ian Willett, Land and Water Resources
Dr Christian Roth, Soil Management and Crop Nutrition

Country Manager

Mr Chris Brittenden, ACIAR Country Manager North Asia

Active projects

at 30 June 2005

Bilateral

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LWR/1998/130	Water resources and salinity management in agricultural areas of inland Northern China and Northern Australia	46
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Project ADP/1998/128: Achieving food security in China - implications of WTO accession

Overseas Collaborating Countries	China
Commissioned Organisation	Australian National University, Asia Pacific School of Economics and Government, Australia
Project Leader	Professor Christopher Findlay Phone: 02-6125 3780, (m) 0416 178 424 Fax: 02 6125 0767 Email: christopher.findlay@anu.edu.au
Project Web Site	http://apseg.anu.edu.au/research/research_units/china/ch_98128.php
Collaborating Institutions	China Centre for Economic Research, China Chinese Academy of Sciences, Centre for Chinese Agricultural Policy, China
Project Budget	$725,246
Project Duration	01/07/2000 to 30/06/2006 (Project extended from 01/07/2003 to 30/06/2006)
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 decisions by the Government determine if 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. Research is needed to examine these questions and their implications to analyse the effect of joining the World Trade Organisation (WTO) on China's food policies, and to devise a set of policies to help improve China's food security.

Project progress

Year 4 (01/07/2004-30/06/2005)

Due to a project extension the next progress report is due early in 2006.

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

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 Chinese Academy of Sciences, Centre for Chinese Agricultural Policy, China
Project Budget	$763,194
Project Duration	01/01/2003 to 31/12/2005
ACIAR Research Program Manager	Dr Ray Trewin

Project background and objectives

China is poorly resourced with water, 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 are threatening supplies. Imbalances in water resources between regions, especially those in the arid north, compared to the more water-rich south, further complicate water supply and equity.

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

Institutional limitations, including no 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. Conflicting needs of industrial, agricultural and urban users further fragment approaches to water allocation. Establishing equitable institutional arrangements in the Yellow River Basin that promote more efficient water allocations and management is being examined to ensure the productivity and sustainability of water will be increased.

Project progress

Year 2 (01/01/2004-31/12/2004)

A framework was established covering:

- primary and secondary data collection and the construction of a basin level database of agricultural production and returns,
- a hydrological database drawing on the structure of the World Bank basin level model of the Yellow River Basin,
- future industrial and urban demand requirements,
- a soil water balance model to facilitate the estimation of total crop water requirements in determining the crop yield response to irrigation, and
- water demand modelling and the construction of an integrated hydrological and economic model of the surface water use in the basin.

The databases of agricultural production and returns, surface water hydrology and soil moisture balance are now mostly complete and the water demand modelling is underway. The agricultural production database contains county level data on dryland and irrigated production, surface and groundwater irrigation water use, yields, revenue and production costs. Data was derived from county level production statistics and both village and farm surveys conducted by the Center for Chinse Agricultural Policy. The database is spatially linked to GIS coverage of the Yellow River Basin that allows the specification of regional estimates that align with catchment boundaries. A hydrological database includes a monthly time series of river flows at key gauging stations and reservoirs, as well as daily pan evaporation and rainfall data from all the available weather stations within catchments of the Yellow River Basin. The soil moisture balance model has been constructed at the county level and can be linked to the GIS coverage of the Yellow River Basin. Water demand estimation procedures have been developed and implemented in GAMS to match the information in the agricultural production database and soil moisture balance models.

Preliminary results from the model are scheduled to be presented at the 2nd International Yellow River Forum in October 2005.

In October, 2004, representatives from ABARE, the Economic Research Service and the International Water Management Institute met with representatives from the Ministry of Water Resources and the Yellow River Conservancy Commission to discuss potential collaboration. The parties agreed to seek support to pursue collaborative research on a variety of issues including the development of water rights to facilitate water transfers, water saving through adoption of irrigation technology and practices, the impact of soil and water conservation practices on sedimentation, water quality and ecosystem protection. It was also agreed that the research would focus on the interrelationships between hydrology, agronomic practices, economic returns and environmental outcomes. Further, the research will assist in the development of a policy evaluation model based on existing ABARE modelling frameworks. The modelling framework may be extended to incorporate water quality, supported by an existing program to monitor water quality in collaboration with the US Department of Agriculture and ecosystems research being done at Yellow River Conservancy Commission.

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

Overseas Collaborating Countries	China
Commissioned Organisation	Australian National University, National Centre for Development Studies, Australia
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Project Web Site	http://apseg.anu.edu.au/staff/jb_suslndrr.php
Collaborating Institutions	China National Forestry Economics and Development Research Centre, China
Project Budget	$399,733
Project Duration	01/01/2003 to 31/12/2005
ACIAR Research Program Manager	Dr Ray Trewin

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 2 (01/01/2004-31/12/2004)

Progress during 2004 was centred on the evaluation of the impacts on farmer household livelihoods of the Conversion of Cropland to Forest and Grassland Programme (CCFGP), a component of the Grain for Green Program. An intensive survey of 400 farmer households involved in the CCFGP across four counties (Binxian, Ansai, Gonghe and Minhe) in two Provinces (Shanxxi and Quinghai) was undertaken.

This was preceded by survey protocol determination, interviewer training and pilot testing of draft questionnaires during a visit to Beijing and the two samples provinces in April/May. Data collected from the survey has been collated and analysed with a research report prepared to first draft stage.

Progress has also been made on the estimation of environmental values associated with the CCFGP. Initial focus groups designed to inform the choice modelling questionnaire design were carried out in Beijing.

The likely environmental impacts of the CCFGP and the integration of those impacts into the economic analysis were investigated. A draft report on the environmental attributes of land use change in the north west has also been prepared. The first two research reports for the project are now available on the project web-site: http://apseg.anu.edu.au/staff/jb_suslndrr.php

Project CIM/1996/006: Wheat improvement in Sichuan Province: application of modern breeding technologies

Overseas Collaborating Countries	China
Commissioned Organisation	University of Southern Queensland, Australia
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Collaborating Institutions	University of Queensland, Australia University of Sydney, Australia Sichuan Academy of Agricultural Science, China Chinese Academy of Agricultural Sciences, China Queensland Department of Primary Industries and Fisheries, Australia
Project Budget	$1,301,184
Project Duration	01/07/1999 to 30/04/2006 (Project extended from 01/01/2006 to 30/04/2006)
ACIAR Research Program Manager	Mr John Cullen

Project background and objectives

Wheat is the second most important crop (after rice) in China's Sichuan Province. About 2.3 million ha are planted each year, and this yields about 7.85 million tonnes of grain. The grain is used mainly for making noodles and bread. However, the quantity does not meet the needs of the current population of 89 million people and the Government is anxious to improve its grain output. It is important that the province improve the efficiency of its wheat breeding efforts. The quality of the grain is also often inadequate for the products it is being used for. Yellow alkaline noodles, a popular food in Japan, China and elsewhere, look unattractive when made with wheat of the incorrect quality. The relevant attributes could be improved with genetic manipulation.

Although the climatic conditions play a part in limiting the yield (inappropriate rain and periods of cold and low light intensity), there are other factors. Firstly there is disease (principally the fungal disease stripe rust); then there is the problem of the premature germination of the wheat grains while still on the stalk, which is faced in Australia as well as Sichuan. Known as sprouting, it is promoted by rainfall coming just before the harvest. Certain wheat varieties — white-grained ones — are inherently more susceptible to this problem. Sprouting resistance exists in some varieties but it is currently difficult to select for in a breeding program because there are no easy markers for it.

Another problem is the intermittent sterility occurring in some wheat types in Sichuan. This could be related to low light intensity because of a naturally cloudy climate, and to cold periods, but resistance genes for this exist. CIMMYT (the International Maize and Wheat Improvement Centre) has been trying to upgrade the productivity of wheat grown in Sichuan by providing elite germplasm and training. However, some of this germplasm, when grown in Sichuan, suffers from intermittent sterility.

The project is working to strengthen wheat breeding capacity in Sichuan and to develop better wheat varieties for the province, and also to provide a better understanding of wheat improvement for noodle quality and sprouting resistance for similar environments in Australia.

Project progress

Year 6 (01/07/2004-30/06/2005)

Analysis of three years of project field data and ten years of Sichuan provincial trial data is being prepared for presentation at the final workshop. This analysis will provide Sichuan wheat breeders with valuable information about breeding strategies and trial placements for their major breeding environments. All training activities have now been completed following the successful visit by three

Sichuan breeders to Adelaide University in March 2005. There they received training in phenotypic analysis of:

- the embryo dormancy component of preharvest sprouting (PHS),
- late maturity alpha amylase (LMA) and
- polyphenol oxidase (PPO).

This training was reinforced by a follow-up visit of Australian project personnel to Chengdu which assisted implementation of these techniques at the Crop Research Institute of the Sichuan Academy of Agricultural Sciences.

Markers for major genes conditioning embryo dormancy have been identified and published. These markers will assist the selection of lines with resistance to preharvest sprouting. Chromosomal regions conditioning the expression of low polyphenol oxidase activity, have been previously identified. Closely linked markers suitable for selection of these regions by breeding programmes are currently being optimised. The effectiveness of these markers in Chinese backgrounds is being assessed.

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

Overseas Collaborating Countries	China, India
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Project Leader	Dr Phil Salisbury Phone: 03 8344 7315, 9884 8068 Fax: 03 8344 4665, 9884 8068 Email: psalisburt@optushome.com.au, p.salisbury@unimelb.edu.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	$2,581,770
Project Duration	01/01/2004 to 31/12/2008
ACIAR Research Program Manager	Mr John Cullen

Project background and objectives

Oilseed brassicas are an extremely important crop in China and India. More than 6 million hectares are planted to *B. 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 resistant 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, and
- developing and providing appropriate information on improved germplasm and disease epidemiology for incorporation into existing technology transfer protocols.

Project progress

Year 1 (01/01/2004-31/12/2004)

Appropriate and effective screening/evaluation protocols identified: During 2004 protocols to be used by all the collaborators for measuring agronomic and disease traits in the agronomy field trials were

discussed and a protocol document was circulated for all collaborators to use. Isolates of Sclerotinia were collected in Western Australia, along with Australian isolates of the white rust pathogen and *Albugo candida*. Screening protocols for white rust resistance were initiated using the Australian isolates. Disease resistance screening was also initiated in India.

Enhanced oilseed Brassica germplasm in all collaborating countries though germplasm exchange, crossing and selection: The enhancement of Brassica germplasm in all countries for the key traits was initiated through the exchange of germplasm among the three countries. Twenty five Australian *B. napus* cultivars, 12 Australian *B. juncea* lines and 20 Chinese *B. napus* cultivars were distributed to the collaborators in each country in late 2004. The seed arrived too late for sowing in the 2004–05 season but the material was multiplied in India and China to provide a larger quantity of seed for the coming season's trials. In addition, some field observations were taken in India and analysis of fatty acid profile and oil content was undertaken.

Efforts were initiated to obtain government approvals for the distribution of the remaining lines (10 *B. juncea* lines from China and 22 *B. juncea* and three *B. napus* lines from India). A list of the characteristics of each of the lines was also distributed to all the collaborators. In total, the exchange of germplasm will result in field trials with 48 *B. napus* and 44 *B. juncea* lines. It is expected that all of the germplasm will be sown in each of the collaborating countries in the 2005–06 season.

Scientific skills of Chinese and Indian scientists enhanced through scientific exchanges and training: Indian scientists from each of the collaborating institutes visited Australia. The visit included two meetings to discuss project plans, including exchange of seed. In addition, the visit included tours of canola field trials in Western Australia and NSW, visits to molecular and chemistry laboratories and meetings with key *Brassica* breeding and research personnel. This scientific exchange and training visit also involved the Indian collaborators participating in the 4th International Crop Science Congress in Brisbane and the Australian Oilseeds Federation Annual Conference in Melbourne.

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

Overseas Collaborating Countries	China
Commissioned Organisation	University of Adelaide, Department of Agronomy and Farming Systems, Australia
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Collaborating Institutions	NSW Department of Primary Industries, Australia Gansu Grassland Ecological Research Institute, China Gansu Agricultural University, China CSIRO Sustainable Ecosystems, Australia
Project Budget	$1,372,554
Project Duration	01/01/2001 to 31/12/2006 (Project extended from 01/01/2005 to 31/12/2006)
ACIAR Research Program Manager	Mr John Cullen

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 practiced 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 progress

Year 4 (01/01/2004-31/12/2004)

China

Evaluate conservation tillage: Conservation tillage experiments continued to provide encouraging results in 2004 at both Dingxi and Xifeng. At the drier Dingxi site, grain yields of wheat and field pea were surprisingly high given the very dry spring conditions. Grain yields from the no till stubble retained treatment continue to be equal or greater than those from the conventional tillage and stubble removed treatment. At Xifeng, grain yield of maize and soybean was slightly higher under no-till stubble compared to when stubble is removed, but grain yield of winter wheat was slightly lower under the former compared to latter.

Overall, no till stubble treatments have performed well across locations, phases (seasons), and crops. It is clear that crops can be successfully grown without tillage and with stubble retained on these Loess soils and in these climate conditions. Another encouraging result is that the benefits of retaining stubble and no tillage occur quickly. Improvements in surface soil water and reduced crust formation are evident in just one season of treatment.

Integrate legumes into cereal based cropping systems: The lucerne — wheat experiments were completed in 2004 with the harvest of the third consecutive wheat crop. Grain yields of 3.7-4.2 t/ha in the absence of nitrogen (N) fertiliser and after three consecutive wheat crops indicate the potential for these soils to mineralise N after a lucerne phase. The response to fertiliser N in these same rotations (5.6-5.9 t/ha) reveals that mineralised N supply alone is inadequate to meet wheat N demand in these systems. After two years and four months of fallow, and a near full soil water profile, grain yield without fertiliser was 5.1 t/ha, and increased to 6.3 t/ha with addition of fertiliser N. The interactions between climate, soil water, soil nitrogen and wheat yield will be analysed using the Agricultural Production Systems SIMulator (APSIM) and long term rotation and N fertiliser strategies identified.

Develop capacity for simulating agricultural production systems: Progress in simulating Gansu production systems has been very good in 2004; made possible through excellent field experimentation and data management. The stage of deriving soil and crop parameters has been largely completed. Performance of the model against observed data has been very good for soil water and plant growth, but several areas require ongoing improvement, including surface soil conditions and runoff and evaporation; winter dormancy physiology in winter wheat and lucerne; and simulation of inorganic nitrogen dynamics.

Given the promising performance of the model some preliminary long-term simulations (Xifeng 1961-2003, Dingxi 1970-2003) were undertaken. A study of long-term average water balances under a range of crop rotations and lucerne has provided new insights and reinforced findings based on experimental results. For example, the water balance is dominated by soil evaporation at Dingxi, runoff and drainage are very small components at this dry site. At the wetter Xifeng site, lucerne can reduce runoff and drainage compared to annual cropping, with implications not only for the local farmer, but also for the wider context surface and groundwater flow systems.

Australia

Integration of lucerne into cereal cropping systems: In 2004 wheat was sown in an experiment comparing phase (after lucerne terminated) or companion (into living lucerne) cropping systems at Roseworthy (South Australia). Growing season rainfall was well below average and there were no significant differences in grain yield between treatments. Under dry conditions and in the presence of lucerne, wheat experienced very severe water stress. The treatments will be repeated in 2005 under hopefully wetter conditions.

APSIM field pea module development: A combination of field research and literature search has resulted in the development of a field pea module that will find application in southern Australia and Gansu. The new field pea module has been included in APSIM releases from version 3.6 and beyond. The model was developed following the standard crop template approach, and has been tested against data from Roseworthy and Dingxi.

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

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 Fax: 03 53622354 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	$1,127,515
Project Duration	01/07/2003 to 30/06/2007
ACIAR Research Program Manager	Mr John Cullen

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 the improved disease resistance and frost tolerance varieties 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 (N) fertiliser inputs to subsequent cereal crops. If these yield increases and cost reductions are realised, this would translate into improved incomes. The genetic improvement of pea and faba bean crops in China and Australia is being undertaken through this project.

Project progress

Year 2 (01/07/2004-30/06/2005)

Collection and exchange of pea and faba bean germplasm: Collecting expeditions were carried out in Qinghai (spring sown) and Yunnan (autumn sown) provinces of China to collect pea and faba bean landraces. Collecting of germplasm was combined with surveys to elicit information on the socio-economic situation of the farms sampled and aspects of on-farm management. Diverse genotypes for both crops were collected and survey results suggest that prices obtained by farmers for their crops are relatively low. Evidence for extreme variation in nitrogen fixation was obtained during the survey in Yunnan, suggesting that a closer look at agronomic practices is warranted to optimise the benefits which can be derived from a legume in a farming system.

Germplasm exchange: Elite breeding material from Australia was sent to China and collected Chinese landraces and a core collection for peas were brought to Australia. Germplasm collected during year 1 in NW Yunnan was processed through quarantine. It is currently undergoing multiplication and initial characterisation (peas in Horsham, faba beans in Tamworth). A second allotment originating from Qinghai is about to be harvested in quarantine. Likewise, material received from Australia was multiplied in Zhangbei and initial observations were carried out by breeders in Qinghai and Yunnan provinces.

Improvement of pea and faba bean breeding programs in China: Disease surveys carried out in Qinghai (2004) and Yunnan (2005) failed to confirmed the importance of root diseases for pea and faba bean production in farmers fields as opposed to research plots. The results of an additional survey in Qinghai by Chinese staff are expected shortly to double check this conclusion. In Qinghai pea breeding is going to focus on powdery mildew resistance while in Yunnan selection for rust resistance and frost tolerance in faba beans are major objectives.

A shuttle breeding program with seed increases alternating between Zhangbei and Kunming was established to service participants in three provinces. Work on molecular characterisation of pea germplasm commenced in Beijing with samples taken during multiplication at Zhangbei. Due to a delay with this work, a preliminary Chinese core collection was compiled on the basis of geographic, characterisation and evaluation data in order to expedite introduction to Australia and enable a comparison with a global core collection in both countries. This will be undertaken during the final phase of the project. Further refinements of both cores will be made when molecular characterisation data become available.

Short-term training of breeders from Qinghai and Yunnan in the use of phytopathological techniques in Australia enhanced the capacity of local programs to establish their own disease and abiotic stress screening nurseries.

Project CIM/2000/038: Use and improvement of sugarcane germplasm

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Plant Industry, Australia
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Collaborating Institutions	Yunnan Sugar Research Institute, China Bureau of Sugar Experiment Stations, Australia Guangzhou Sugarcane Industry Research Institute, China CSR, Australia
Project Budget	$1,411,753
Project Duration	01/07/2002 to 30/06/2007
ACIAR Research Program Manager	Mr John Cullen

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 agronomicalyl 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 3 (01/07/2004-30/06/2005)

Assess genetic diversity in germplasm collections and select a core set of clones for future breeding: Work on genetic characterisation of germplasm collected from China and other parts of the world has been almost completed, with data analysis and manuscript writing underway. Characterisation of *Erianthus arundinaceus* from China has been completed. The results 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.

Characterisation of all non-Chinese *Saccharum spontaneum* clones (including clones from Australian, US and Brazilian collections) has been finished. Characterisation of the Chinese *S. spontaneum* in the laboratory at YSRI has proven problematic and is still being completed. Final analysis of data for *S. spontaneum* has been awaiting final laboratory analysis at YSRI. This analysis will be used in helping to target small sets of clones from both species that represent most available genetic diversity for use in Chinese and Australian collections.

Develop improved clones derived from wild germplasm: A further 40 crosses were made at the Yunnan Sugar Research Institute (YSRI) and the Guangzhou Sugarcane Industry Research Institute (GSIRI) in 2003–04 from parents derived from wild clones collected in China. These involved crossing the clones derived from basic germplasm clones with either *S. officinarum* or with commercial type varieties. Some seed has been sown in China, while some seed has been brought to Australia. Generally for most crosses, about half the seed is kept in China and half taken to Australia. The project team liaised with AQIS in developing quarantine protocols for importing this material to Australia, as it is the first time true sugarcane seed (as opposed to vegetative cuttings) have been imported. Families and individual clones derived from these crosses are being evaluated in China and Australia, and families and clones with good performance and capturing new sources of genetic variability will be used for further breeding.

Evaluate DNA marker assisted introgression of exotic germplasm in sugarcane improvement: Populations have been produced and were successfully established in replicated field trials in Yunnan, Guangzhou and Australia in 2004–05. 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. Marker characterisation on these populations has commenced at YSRI and GSIRI.

Undertake GxE studies between China and Australia: Twenty six clones are currently undergoing a second cycle of propagation in Yunnan, Guangdong and Australia, in preparation for planting field trials in 2005–06. These include 15 unselected clones and six cultivars extensively evaluated across many environments in Australia, and three other cultivars grown in China and available in Australia.

Develop capability in YSRI and GSIRI in application of molecular marker technology and sugarcane breeding: Molecular marker laboratories at both YSRI and GSIRI have been developed and both micro-satellite and Amplified Fragment Length Polymorphism markers are being run. These markers are the main ones being applied in the current project, and are currently the most widely used in sugarcane generally.

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

Overseas Collaborating Countries	China
Commissioned Organisation	University of Adelaide, Department of Agronomy and Farming Systems, Australia
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Collaborating Institutions	Tibet Agricultural Research Institute, China
Project Budget	$375,701
Project Duration	01/01/2004 to 31/12/2006
ACIAR Research Program Manager	Mr John Cullen

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, 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 1 (01/01/2004-31/12/2004)

Three scientists from the Tibet Agricultural Research Institute (TARI) spent 12 weeks in Australia hosted by the University of Adelaide (Roseworthy Campus). Their work concentrated on spoken and written English development, research methodology and research writing. In particular, the preparation of a review paper on past agronomic research in Tibet Autonomous Region provided a focus for their training. The TARI visitors also worked on understanding the requirements for the development of a simple climate/environment based crop model. A research work plan was prepared while still in Australia and soon after their return to the Tibet Autonomous Region this plan was implemented with the assistance of the project Research Officer.

The Research Officer was stationed in Tibet for 12 weeks, and guided TARI staff in establishing three experiment sites representing three distinct maturity environments. The experiments involved a replacement series with already established winter wheat into which was sown vetch. Basically this experiment was planned as a training exercise in research methodology and a focus for the 2005 field trials. Many lessons were learnt about constraints and understanding, and also useful data were obtained on light input (Leaf area index) and competition with the wheat and vetch.

The Research Officer was also able to identify best site opportunities and germplasm availability (wheat, barley, lucerne) for the 2005 program. Another important aspect of this training phase resulted from the input of a new project in Tibet Autonomous Region supported by FAO, and the dependency of the FAO project on the TARI staff trained within the ACIAR project.

In Australia a glasshouse experiment investigating hydraulic lift (pigeon pea, sunflower) and a field experiment with wheat and pigeon pea sown as a relay intercrop were undertaken. Both these experiments involved input from the TARI staff whilst they were in Australia. The purpose of the intercrop experiment was to establish if a crop such as pigeon pea can be utilised to de-water soil during a summer growth period on soils prone to stress due to winter-spring waterlogging. The experiment undertaken in 2004 involved different seeding rates and row spatial arrangement, with two wheat cultivars. Pigeon pea was sown into the wheat crop in September.

At this stage only wheat yield data are available, with a range of yield from 2.5-5.0t/ha. Leaf area index was also measured throughout the growing season with all treatments, and important interactions were observed in potential competition between the seeding rates, row spacing and varieties. Finally, 15 pigeon pea cultivars (some with waterlogging tolerance) were sourced from ICRISAT (India) and grown for seed production in quarantine. The generated seed is now being bulked up for inclusion in experiments as part of the Australian component of this project.

Project CP/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

Overseas Collaborating Countries	China
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Extension, Australia
Project Leader	Ms Bronwyn Walsh Phone: (07) 5466 2222, mobile 040 8747 342 Fax: (07) 5462 3223 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	$398,768
Project Duration	01/07/2003 to 31/12/2005
ACIAR Research Program Manager	Dr T K Lim

Project background and objectives

Brassica crops in tropical and sub-tropical environments are difficult to manage. Pests and diseases are common, requiring farmers to make complex management decisions. Chemical spraying is the main option chosen, being relatively simple to implement. Pests are, however, becoming resistant to chemicals, residues in produce are a major issue of concern from a consumer perspective as is farmer health and management from exposure to chemicals. In China, Brassica vegetables account for about 50 per cent of total vegetable production and consumption. Controls against insect pests and diseases are in the form of chemicals. Changes in farm organisation from collective to individual farms have weakened the extension networks and diminished the flow of information for decision-making. Where previously extension officers interacted with collectives, today the onus for decision-making is on individual farmers who have little if any contact with extension networks and who are mainly familiar with chemical controls, rather than alternatives.

One alternative approach is integrated crop management, relying on management practices based on utilising the right information. Concerns about safety in vegetable production and of residues in produce have prompted all levels of government in China to implement integrated crop management. In Australia much research has been conducted on the subject, with ACIAR-supported research being conducted overseas. This has developed a range of information, but to date this has not been packaged into a manageable toolkit. A multi-media approach to developing such a package is being undertaken to substantially improve information flows.

Project progress

Year 2 (01/07/2004-30/06/2005)

There has been significant progress in developing the decision support toolkit based on the results of the needs analyses. The current beta prototype for Australian end-users includes a diagnostic key and 165 fact sheets within a similar content and framework to China. The prototype has been through one testing cycle with extension officers.

In Zhejiang, China, following the extensive needs analysis conducted in early 2004, the team developed two tools:

- a decision-support and training multimedia system targeted mainly at extension officers, and
- a field guide to integrated management of vegetable brassicas targeted mainly at farmers.

Preliminary frameworks for the two tools were developed and improved through extensive interaction at special workshops and focus groups. Extensive effort then accessed knowledge and information from literature, expert experience and documents from agricultural organisations to be incorporated into the tools. Several software packages, including Dreamweaver 7.01, Lucid3, Search Engine Builder Standard 2.06, Dvbbs 7.0.0 Sp2, and Camtasia Studio 3.0.2, were used in the development of the multimedia system. A beta prototype of the multimedia system was developed by May 2005 and tested by extension officers in May-June 2005.

The current beta prototype consists of seven subsystems:

- crop cultivation introduces the morphology, growth characteristics, species and cultivars, and methods of cultivation for 11 common species of crucifer vegetables,
- fact sheets present the information and knowledge of 43 species of plant diseases, 18 species of insect pests, 14 species of weeds and 14 species of natural enemies,
- pesticides introduces the frequently used pesticides,
- diagnosis and identification provides an effective platform for diagnosis of plant diseases and disorders and identification of insects and weeds, using Lucid as the major interface,
- pesticide application introduces the correct methods and regulations of pesticide application, including the basic information on each pesticide, safe and strategic application of pesticides, information of sensitivity of crops to various pesticides, pre-harvest withholding periods of various pesticides,
- glossary provides 300 entries of common terms used in the system, and
- other information includes system help, basic knowledge of integrated crop management, useful websites, references, and acknowledgements.

By taking into consideration of the feedbacks from the preliminary tests, a formal beta prototype of the multimedia system will be produced then widely tested in the field in the following months.

Compilation of the field guide for farmers progressed. The guide offers concise descriptions and practical reference for identifications of brassica pests, diseases and disorders and presents 221 photos of high resolution to assist in field identification. Apart from offering background information and general management strategies for individual pests and diseases, the guide presents management protocols for individual crops through a season, especially the strategic application of pesticides. One thousand copies of the field guide were printed in early June 2004, and distributed to farmers at the 10 major vegetable production areas in Zhejiang. In Hangzhou, Wenzhou and Cixi, the field guide was used in three field days conduced in mid-late June 2004. The field guide was welcomed by the farmers at the field days.

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

Overseas Collaborating Countries	China, Vietnam
Commissioned Organisation	State Forests of New South Wales, 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	$682,613
Project Duration	01/07/2005 to 30/06/2009
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Eucalypts are a potential high-value wood for use in construction joinery and furniture. 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. Research will focus on genetic and silvicultural controls to reduce losses. (Other research is examining sawing methods). Breeding strategies and management regimes will be examined, beginning with an overview of plantation resources. Levels of control offered by genetic and silviculture will be assessed to increase quality and other critical traits. Breeding strategies for key species will be developed and communicated, enhancing capacity building.

Project progress

Year 1 (01/07/2005 to 30/06/2006)

The first progress report is due in 2006.

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

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	$150,000
Project Duration	01/07/2002 to 31/12/2005 (Project extended from 01/07/2004 to 31/12/2005)
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 2 (01/07/2004-30/06/2005)

Due to extensive animal damage to field trials and experiments planted last year progress has been slow, with the project given an unfunded extension to complete this work.

Carry out assessment on the long-term forest health risk associated with the introduced P. radiata in Aba: A report on forest health risks associated with the long term introduction of *Pinus radaita* in the dry river valley area is being prepared.

Integrate site, climatic information and knowledge on provenance performances elsewhere in the world through climate modelling to match provenances to sites: A research paper on assessing climatic suitability of southwest China for ecological plantings of *Pinus radiata* will soon be submitted for journal publication.

Establish provenance trials to systematically evaluate provenance performances over different site classes in Aba: The survival and growth of seedlings were assessed in 2005, but was significantly hampered due to problems with the field trials and experiments.

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

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 International Centre for Tropical Agriculture, Laos
Project Budget	$938,899
Project Duration	01/01/2001 to 30/06/2007 (Project extended from 01/01/2005 to 30/06/2007)
ACIAR Research Program Manager	Dr Bill Winter

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, as well as 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 perennials plants to keep watertables 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 and soil stability, and lower watertables. 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 aims to produce lucerne varieties that are adapted to environmental stresses relevant to China and Australia through the development of germplasm and novel screening techniques.

Project progress

Year 4 (01/01/2004-31/12/2004)

Acquisition and field testing of germplasm: The germplasm being grown at the Waite Campus in Adelaide has been characterised over a full year. Characterisation of rhizobia collected from Chinese soils was continued and diversity of material estimated using molecular markers. Measurement and assessment of trials has continued at all sites in China and Australia using a revised measurement protocol. Multiplication continued with new larger scale plots established by the Gansu Agricultural University collaborators at Jingtai, Gansu.

Further trials were established in Laos with the collaborators. Forty-eight lucerne trials were established across two provinces, five districts and 28 villages. The establishment of these trials was excellent with all trials showing excellent germination and early growth. Although all the trials were successfully sewn, relatively few were growing well by November. This is thought to be largely due to soil acidity and poor soil fertility at the selected sites. These are predominantly on acid soils where lucerne would not normally be expected to perform well in the absence of treatments such as liming. However, other soil types exist in Laos, for example in the valley floors or on limestone hilltops, where better lucerne performance would be expected. Future trials will now target these new areas.

Developing novel screening techniques: Aluminium screening continued with the first of the progeny from previous selections tested against the parent material. The results of these experiments revealed the progeny were much more aluminium tolerant than the parent material. Further selections were made from this material and will be available for retesting. A large amount of acid soil from Mt Pleasant SA was collected for use in validating the screening work and experiments commenced to characterise this soil. Salinity work continued in Tasmania with a range of parameters measured to characterise the response to salt stress of genetically diverse plant material. Material with different genetic background appears to have different tolerance mechanisms and this may reflect adaptation to differing levels of salt stress.

Delivering well-adapted germplasm to seed producers and breeders: Some of the commercial entries in the Chinese trials performed so well in the trials that registration of this material will commence in 2005. The aluminium tolerance screening has already supplied material to breeding programs and retested the progeny of this material. Further selection cycles will continue in 2005.

Training and extension: 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 Crop Science Congress in Brisbane and at the International Conference on Plant Anaerobiosis. Project activities and research have featured in a number of articles in Australian electronic and print press.

Project LPS/1998/035: Ruminant production in the red soils region of southern China and in northern Australia

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
Collaborating Institutions	CSIRO Sustainable Ecosystems, Australia Jiangxi Agricultural University, China Department of Rural and Social Development, Jiangxi, China Chinese Academy of Agricultural Sciences, China
Project Budget	$938,181
Project Duration	01/07/2001 to 30/06/2006 (Project extended from 01/01/2005 to 30/06/2006)
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

The red soils region of central southern China covers an area the size of Western Australia (2.6 million km2) to the south of the Yangtze River. The region is characterised by high and soil erosive rainfall in spring, high evaporation rates in summer and cold winters. Almost half of this area has become seriously eroded as a result of excessive deforestation. There is increasing pressure to develop these soils for agricultural production, due to population pressure and economic growth. Three previous ACIAR projects have delivered technologies for establishment and persistence of pasture forages to help control erosion. The challenge for this project is converting these adapted forages into economic benefits for farmers, by developing a forage-based ruminant production system that integrates well with other activities of smallholder farmers.

The provincial government in Jiangxi, through the Ministry of Science and Technology and Planning Commission, had allocated 150 million Yuan (A$34 million) for the development of forages to increase ruminant production. In China technology development is focussing on ‘cut-and-carry’ systems of beef production, to avoid the negative effects that free-range cattle would have on the soils and farming infrastructure. Education and training in feeding strategies are also being made easier with stall-fed animals. Developing economically viable pasture-based beef production systems in the degraded red and yellow soils regions of southern China, will help in meeting the rapidly expanding domestic beef market in China and in reducing erosion.

Project progress

Year 4 (01/01/2005-31/12/2005)

Due to a project extension the next project progress report is due early in 2006.

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

Overseas Collaborating Countries	China
Commissioned Organisation	Charles Sturt University, Australia
Project Leader	Professor David Kemp Phone: 02 6360 5526, 0409 443 451 Fax: 02 6360 5590, 02 6362 7625 Email: David.Kemp@orange.usyd.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
Project Budget	$649,703
Project Duration	01/01/2005 to 30/06/2007
ACIAR Research Program Manager	Dr Bill Winter

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 1 (01/01/2005 to 31/12/2005)

The first progress report is due in 2006.

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

Overseas Collaborating Countries	China
Commissioned Organisation	NSW Department of Primary Industries, Australia
Project Leader	Dr Alan Kaiser Phone: 02 6938 1852 Fax: 02 6938 1809 Email: alan.kaiser@agric.nsw.gov.au
Collaborating Institutions	Tibet Academy of Agricultural and Animal Sciences, China Tibet Livestock Research Institute, China
Project Budget	$399,669
Project Duration	01/07/2004 to 30/06/2007
ACIAR Research Program Manager	Dr Bill Winter

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. The project is, through introducing improved nutrition options, 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 1 (01/07/2004-30/06/2005)

The focus during the early stages of the project in Tibet has been on the on-farm research component. Milk production and feed inputs during a complete 12 month production cycle are being monitored on 37 small holder milk enterprises (approximately 200 cattle) in the valleys of central Tibet AR. In addition, reproductive performance of the cows will be monitored over two years. The study will allow us to develop the relationships between feed offered (quantity and quality), milk production and reproduction. The participatory research approach adopted — involving researchers, extension staff and farmers — will facilitate technology transfer.

A set of comprehensive spreadsheets has been developed to collect information on:

- farm inventory — livestock, farm size, labour force, machinery,
- farm enterprises — milk sales, crop production and sales, other enterprises,
- cattle inventory — age, genotype, reproductive status, sales,

- reproduction — mating and calving records for cows (including details of Artificial Insemination),
- feed and milk — milk production and associated feed inputs at 2-weekly intervals,
- sale of milk and dairy products (yoghurt, butter, cheese), and
- other cattle — male stock and replacement females, feed input, heart girth measurements

The Australian component of the project is aimed at optimising animal production from conserved (silage) cereal and cereal/legume silages. Crops were sown in June 2005, at the end of the current reporting period. A field experiment is comparing the forage quality from seven cereals (three wheat, two barley, two oats) grown alone or with vetch. Each crop is to be harvested in spring at four stages of growth — boot, ear emergence, milk and dough. Silages are being produced from barley and oat crops, each harvested in spring and at three stages of growth (ear emergence, milk and dough).

Project LPS/2002/108: Improved management of small mammals in Tibetan grasslands

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Sustainable Ecosystems, Australia
Project Leader	Dr Roger Pech Phone: 02 6242 1657 Fax: 02 6242 1555 Email: Roger.Pech@csiro.au
Collaborating Institutions	Chinese Academy of Sciences, China Department of Agriculture of Tibet Autonomous Region, China Tibet Bureau of Agriculture and Animal Husbandry, China Tibet Academy of Agricultural and Animal Sciences, China
Project Budget	$399,948
Project Duration	01/10/2003 to 31/03/2006
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

Grasslands in western China, particularly Tibet Autonomous Region, are important for livestock farming systems. These systems are important for maintaining traditional farming approaches, based on competing for scarce resources. These traditional systems form the basis of the Tibetan farming economy. Amongst the competition for forages are rodents and other small mammals. Through their eating and burrowing activities they contribute to soil erosion and plant losses, resulting in grassland degradation. Small mammals and rodents have degraded up to 15 per cent of the valuable grassland ecosystems on which Tibetan farmers depend.

Control operations against these small mammals currently use non-specific toxins across an area that covers 1,600,00 hectares. Species biology and habits are not incorporated into this broad-scale approach. In some places this has been very effective in eradicating up to 95 per cent of rodents. But this level of effectiveness has been substantially less in most areas.

The main animal studied is the plateau pika, the keystone species. Determining effective control techniques for the pika is focusing on areas used for summer grazing. The effects and role of pasture management in these will also be assessed. The impact of these measures are being assessed for non-target species, such as other pikas, zokors and marmots, as well as birds. An immuno-contraceptive vaccine, administered through appropriate oral delivery systems, is also being examined. Meeting these objectives will help in the development of ecologically-based options for farmers to manage mouse plagues in south-eastern Australia's cereal production areas.

Project progress

Year 2 (01/10/2004-30/09/2005)

Effectiveness of current control techniques for plateau pikas in summer and winter grazing areas: The data collected during 2004 were analysed in detail to review the effectiveness of field methods and to assess changes in pika populations and vegetation over the summer season of 2004 (April to September). Also data from September 2004 and April 2005 provide some indications of changes in pika populations over winter. Several modifications to protocols were successfully implemented to improve the consistency of field observations between observers and the work program for April 2005 was expanded to enable improved calibration of data collected by members of the project team.

The key results show current control techniques can be highly effective in achieving immediate reductions in the abundance of pikas in spring, but there is no evidence of long-term control of pika populations. Pikas appear to have better over-winter survival in areas fenced to conserve forage for winter grazing by livestock. Although the result is higher abundance of pikas inside fenced areas compared to adjacent unfenced areas at the start of spring each year, this is offset by a slower rate of

increase over summer in areas with initially high population density. The abundance of pikas in spring is positively correlated with the number of burrow entrances, which ranges from approximately 400 per ha to more than 2300 per ha at the project's study sites.

Impact of pika control on non-target species: Road-based surveys indicate a consistently high abundance of raptors (e.g. species such as upland buzzards that prey on pikas) over much of the high altitude grasslands between Lhasa and Naqu and throughout the part of Naqu County where the study sites are located. Surveys to provide critical baseline information of pika control on species of raptors reported to be declining in other parts of the Qinghai-Tibet plateau are underway. In September 2004 and April 2005, surveys were conducted of small bird species that rely on pika burrows for nest sites. The data gathered to date suggest there have been few if any short term impacts of pika control on a wide range of bird species, but effective long-term control of pikas could reduce the abundance of raptors and small passerines.

Increase skills in Tibet in small mammal population ecology, survey techniques and data analysis: Chinese scientists and field staff have been involved in all aspects of the development, implementation and refinement of the experimental program in Tibet. A project meeting in Lhasa attended by representatives of partner agencies endorsed the project's objectives and strongly supported continuation and future expansion of the project. Chinese team members have been impressed by the sustained focus on key issues and the willingness to engage in open debate on scientific issues. The visit to Australia by scientists from the Tibet Academy of Agriculture and Animal Sciences and North West Plateau Institute of Biology included training in data analysis techniques, detailed analyses of field data, report preparation and formal scientific presentations.

Oral delivery system for immuno-contraceptive vaccines: The first experiment using Brandt's voles was conducted between August and November in Beijing. Voles were treated with the vole ZP3 specific peptide which had been conjugated to an immune enhancer. The voles received either an intramuscular treatment or an intra-intestinal primary dose followed by three boosts at three to four week intervals. A control group received adjuvant only at the corresponding times. All animals were placed with males two weeks after the last boost and production of litters monitored. Enzyme-linked immunoassays were established to measure the serum immune responses to the peptide and to the immune enhancer.

Immune responses to both antigens were detected in the serum of voles treated intramuscularly, but not in those treated intra-intestinally. When the serum from animals was used to test binding of antibodies to ovarian sections a similar response was observed; binding was only detected in serum from intramuscularly treated animals. All animals were fertile. A subsequent trial is being undertaken with a different immune enhancer. A second set of experiments have been conducted using a combination of steroids (progesterone and/or oestrogen) delivered orally to male and female Brandt's voles. Preliminary analyses indicate that there are effects on spermatogenesis in males treated with oestrogen alone.

Project LWR/1998/130: Water resources and salinity management in agricultural areas of inland Northern China and Northern Australia

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Land and Water, Australia
Project Leader	Dr Ali Riasat Phone: (08) 9333 6329 Fax: (08) 9333 6211
Project Web Site	http://www.clw.csiro.au
Collaborating Institutions	Changchun Institute of Geography, Chinese Academy of Sciences, China Ningxia Bureau of Geology and Mineral Resources, China
Project Budget	$993,358
Project Duration	01/01/2001 to 30/09/2005 (Project extended from 01/01/2005 to 30/09/2005)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

As a result of its extensive use of irrigation to expand agricultural activity over the last few decades, many areas of Northern China now suffer shortages of domestic and irrigation water supplies; an expansion of water-logged areas; the development of alkaline, sodic or saline soils; depletion and contamination of groundwater; increasing saline discharges to lakes and rivers; and nutrients and pollutants contaminating surface soil and water. Western Australia's Ord Bonaparte project is poised to increase its irrigated area from the current 13,000 ha to 60,000 ha. To manage such a large irrigated area sustainably, and prevent similar problems, planners will need reliable data and a good understanding of the entire catchment region.

This project is developing a holistic understanding of the surface and groundwater hydrology of three regions:

- the Yinchuan Plain, in Ningxia province, where agriculture is sustained by irrigation from the Yellow River and most of the cities and villages rely on groundwater aquifers;
- the Songnen Plain, in Jilin and Heilongjiang provinces, where the climate is semi-arid and agriculture relies on irrigation from the Songhua River and from groundwater; and
- the Ord River Irrigation Area in Western Australia, also in a semi-arid zone and now being developed to use the water flows from the Ord Dam.

Appropriate amounts to be pumped from different aquifers in each area without depleting them or endangering water quality with salinity are being determined. Combined with other factors, this could make more water available, increase crop production and maintain environmental quality. Water and salinity management in irrigated areas of northern China and the Ord River (WA) are being improved, increasing the availability of water for crop production and reducing salt discharges to rivers.

Project progress

Year 4 (01/01/2004-31/12/2004)

A computerised GIS-Database established for the Yinchuan Plain in Ningxia; the Songnen Plain in Changchun and the Ord in Australia has been successfully used in the development of various surface water, groundwater and geochemical models. These data together with aerial photography and remote sensing have also been used in the mapping of salt/alkaline affected areas in the Yinchuan and Songnen plains.

Data collection, from all experimental sites, including from previous years, were analysed to produce outputs and develop various surface water and groundwater models. Development and calibration of various models was completed with the help of collected data.

Yinchuan Groundwater Resources: A groundwater model for each of the three aquifers has been developed and calibrated. A number of 'what-if' scenarios have been formulated for modelling. Interconnection between these three aquifers using isotopes techniques has been determined. The impacts of pumping shallow groundwater on water quality and quantity have been evaluated. The main findings are:

- shallow groundwater in the Yinchaun Plain is mainly controlled by both stationary and dynamic surface water bodies,
- leakage from irrigation and drainage systems is one of the primary sources of groundwater recharge,
- excessive irrigation also contributes to a significant portion of total groundwater recharge,
- during most of the year, groundwater discharges to the Yellow River, and
- during irrigation periods the lakes are recharged by groundwater and during times of no irrigation the groundwater is recharged by lakes.

Following from these findings, the government of Ningxia province has taken steps to reduce the leakage from irrigation and drainage systems. This will help lower the groundwater levels and soil salinity in the Yinchuan Plain. Modelling of 'what-if' scenarios is currently underway which will help devise best management strategies for the long term sustainability of groundwater resources of the Yinchuan Plain. The Ningxia Academy of Agriculture and Forestry program has been conducting field experiments on new irrigation techniques, water saving techniques, estimation of seepage from irrigation structures and effects of using shallow groundwater for irrigation. The field experimental data have been analysed to improve water use efficiency, feasibility of conjunctive water use and minimise seepage from irrigation system.

A surface water model (LASCAM) was developed for the Ord, Songnen Plain and Yinchuan Plain to study the impacts of landuse and climate change on the quantity and quality of flow from the catchment. The model was successfully calibrated using the long term flow and quality data. A groundwater model for assessing the feasibility and offsite impacts of using groundwater irrigation in closed depressions (Dongdapao irrigation area and Songnen Plain) including regional groundwater system that supplies the depressions and water balance of the Tao'er River was developed and calibrated. Field data have been collected and models for determining water use efficiencies for various crops and soil types have been constructed.

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

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Land and Water, Australia
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Project Web Site	http://www.eoc.csiro.au/aciar/book/index.html ;http://www.clw.csiro.au/research/catchment/modelling/; http://www.eoc.csiro.au/aciar/book/index.html
Collaborating Institutions	Chinese Academy of Sciences and Ministry of Water Resources, Institute of Soil and Water Conservation, China
Project Budget	$723,378
Project Duration	01/01/2003 to 31/12/2005
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 is working 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 progress

Year 2 (01/01/2004-31/12/2004)

The main focus of activities was on quality control on the Chinese databases, and spatially interpolating the point based meteorological data. Five main databases have been checked and developed:

- contour, spot height and river data used to develop a hydrologically correct Digital Elevation Model (DEM),
- soils data used in vegetation suitability modelling,
- time series (1980, 1986, 1993 and 1997) land-use data,
- monthly meteorological database from 1980 to 2000 (21 years), and
- monthly hydrological database, again from 1980 to 2000 (21 years).

Developing a hydrologically correct DEM: A hydrologically correct DEM was developed with input data for contours, spot heights and river networks. Key parameters were optimised to ensure highest quality output. Given the controlling influence of landform on all water (and soil) processes occurring in the Loess Plateau, having a hydrologically correct DEM was a high priority. The DEM was used in 4 fundamental ways: defining the sub-catchments that comprise the study area; (defining the area contributing runoff to each hydrological station; as a covariate from which to perform the spatial interpolation of the meteorological database; and input to calculate solar radiation taking slopes and aspect into account.

Correcting digital soils map: The soils database was carefully assessed for errors; this included ensuring that all digital map codes were identical to the paper map. This improved the overall coherence of the digital data set, and meant that subsequent vegetation suitability modelling would be more reliable.

Assessing the validity of the time series of land-use maps: Four land-use maps were available (1980, 1986, 1993 and 1997) to monitor the land-use change from 1980 to 1997 and the results of the re-vegetation program. The maps were combined from different classes into one common classification system. Upon careful checking of the common class data it was found that there was no logical explanation for the progression of land-uses for many individual pixels, and therefore we could not perform the monitoring on a spatial (per-pixel basis). Use of high resolution remote sensing to re-label 1997 polygons was inspected, but rejected as 90 per cent of the 96,000 polygons would require redigitising. A 1986 data was deemed by ISWC as the only dataset reliable enough to use to correct this.

Checking, and spatially interpolating the monthly meteorological database: The meteorological data measured at the isolated stations in and around the CSHC required quality control checks prior to monthly surfaces being spatially interpolated (using ANUSPLIN). These quality control analyses were performed systematically using computer programs; as a result of this process, the input data was of much higher quality. The complex topography of the CSHC, however, meant that the spatial interpolation was more difficult than previously expected (based on experience from relatively flat Australia).

Checking the monthly hydrological database: The systematic quality control of the hydrological database was performed with many errors successfully corrected. This effort means that the final datasets are of high quality to perform the model validation, which is critical to project success. Detailed hydrologic understanding has been gained from analysis of experimental and point based data. In addition to re-vegetation programs, other engineering works — mainly sediment trapping dams and terraces — have been pursued in the Loess Plateau.

The sediment trapping dams are usually small earth dams built across gullies that slow the movement of the water allowing the soil to drop-out of solution. Over time, and due to the high erosion rates, dams fill with soil creating ‘new’ horizontal farmland. Given that both the dams and terraces slow water, there may be greater opportunity for water to evaporate back into the atmosphere or infiltrate into the soil.

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

Overseas Collaborating Countries	China
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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 Ian Willett

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 1 (01/07/2005 to 30/06/2006)

The first progress report is due in 2006.

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

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Land and Water, Australia
Project Leader	Mr John Blackwell Phone: 02 69601521 Fax: 02 69601600 Email: john.blackwell@csiro.au
Collaborating Institutions	China Institute of Water Resources and Hydropower Research, China Department of Water Resources, China
Project Budget	$399,941
Project Duration	01/04/2004 to 30/06/2006
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 is promoting the use of FILTER in Shanxi Province.

Project progress

Year 1 (01/04/2004-31/03/2005)

Develop and field test innovative FILTER techniques for sustainable irrigation with wastewater at a demonstration site: The focus of the research studies in the first cropping season was to evaluate the soil physical properties at the experimental site, to facilitate designing of the appropriate horizontal or vertical drainage system to allow adoption of the modified FILTER technology at the site, in the following seasons.

A modified plan of the instrumentation for automatic measurement of the soil physical properties was developed and the field instruments were installed. Soil pits were dug in the centre of each of the three plots to be used in the field trial. Instruments to measure soil matric potential, soil moisture content and temperature were installed at different depths in each plot. The cables from these instruments lead to a junction box which is connected to a data logger powered by a solar panel. Subsequently, an automatic weather station was also connected to the data logger. From each plot undisturbed soil cores were collected at different soil depths for the characterisation of soil physical and chemical properties.

Due to the trial being installed on a farmer's field with an established maize crop, irrigation could only be potentially applied at a low rate when required to supplement rainfall. However, due to receipt of plenty of rainfall during the summer cropping season, supplementary irrigation was not required to be applied. After carrying out land preparation for the following winter season and subsequent summer

cropping seasons, a higher hydraulic loading will be used. This will allow an evaluation of the efficacy of maintaining high hydraulic flows and pollutant removal at the site.

A visit was undertaken in November 2004 by the Australian research team to Shanxi to initiate monitoring of different management options for enhancing cold weather wastewater infiltration. Prior to the visit, discussions were held with the Shanxi researchers on preparing the site for wastewater ponding on a flattened soil surface, with high bunds around each of the plots.

The analysis of the data on the soil physical properties at the field site and on-field observations indicates that the soils at the site have high hydraulic permeability and deep watertables. The site therefore appears to be more suitable for a modified FILTER system with a vertical drainage system. On the basis of hydrogeological properties at the experimental site, a radial flow model of a FILTER site is being developed to test recharge, pumping and drawdown scenarios.

Promote the application of FILTER and other technology for sustainable irrigation with wastewater in Shanxi and other Chinese provinces: Potential sites for adopting new approaches to wastewater renovation and discussions with the wastewater managers on the potential application of FILTER technology with suitable modifications were investigated. A dialogue has been developed with wastewater managers in Lake Dianchi in Kumung-Yunnan Province, Beijing Water Commission and central government authorities attached to MOST.

Institute of Water Resources And Hydropower Research scientists have developed a novel approach to modifying FILTER systems for application in the cold winter areas in northern China, by combining FILTER with existing polyhouses providing around-the-year crop production for urban centres in northern China. A preliminary trial site has been established in the Beijing Water Commission area to develop and test the efficacy and potential application of the combined technologies.

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

Overseas Collaborating Countries	China
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Collaborating Institutions	Shanxi Academy of Agricultural Sciences, China Chinese Academy of Sciences, China ACIL Australia Pty Ltd, Australia Chinese Academy of Agricultural Sciences, China China Agricultural University, China
Project Budget	$1,340,326
Project Duration	01/04/2005 to 31/03/2009
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

In China irrigated cropping is often practiced, demanding 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 practiced demands the use of fertilisers. Nitrogen 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 genuine environmental problems, beginning with nitrogen-rich runoff. Volatisation of ammonia, where this is converted to vapour, 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 on 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 N2O 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 1 (01/04/2005 to 31/03/2006)

The first progress report is due in 2006.

Project PHT/1998/137: Integrating effective phosphine fumigation practices into grain storage systems in China, Vietnam and Australia

Overseas Collaborating Countries	China, Vietnam
Commissioned Organisation	Queensland Department of Primary Industries and Fisheries, Farming Systems Institute, Australia
Project Leader	Dr Patrick Collins Phone: 07 38969433 Fax: 07 38969446 Email: pat.collins@dpi.qld.gov.au
Collaborating Institutions	Zhengzhou Grain College, China State Administration of Grain, China Guangdong Institute of Cereal Science Research, China Postharvest Technology Institute, Vietnam Chengdu Grain Storage Research Institute, China Ministry of Agriculture and Rural Development, Vietnam
Project Budget	$747,602
Project Duration	01/01/2001 to 31/12/2005 (Project extended from 01/07/2004 to 31/12/2005)
ACIAR Research Program Manager	Dr Greg Johnson

Project background and objectives

Australia (about 25-30 million tonnes), China (495 million tonnes) and Vietnam (30 million tonnes) produce significant grain harvests each year, including rice, wheat, maize and other grains. Each country fumigates about 80 per cent of this grain with phosphine. Due to the combined advantages of low cost, ease of use and acceptance as a residue-free treatment, this fumigant will remain the central component of insect pest management for the foreseeable future in Australia and throughout Asia. However, scientists in an earlier ACIAR project identified that resistance in target pests threatens the continued viability of this fumigant. It also became apparent that several other factors, in addition to resistance, were contributing to control failures with phosphine.

To ensure the continued viability of phosphine technical innovations to enhance the efficacy of phosphine and the development of management strategies to control several psocid species are needed. These have developed as a major problem in stored grain in China. Psocids have also emerged as a major problem in Australia, and initial work here has shown that resistance to phosphine is an important factor, but ecological aspects may also be important.

This project will formulate and verify national fumigation standards for China, Vietnam and Australia, improve fumigation practice in China and Vietnam by undertaking training programs, investigate potential innovations to enhance the efficacy of phosphine fumigation, and determine the key factors preventing effective control of psocids with phosphine. This will protect and enhance the utility of phosphine as a fumigant for grain and to more fully integrate it into pest management in grain storage systems.

Project progress

Year 4 (01/01/2004-31/12/2004)

Formulate and verify national fumigation standards (develop and submit for approval phosphine fumigation standards for Vietnam): Effective disinfestation systems for grains are essential for Vietnam to access international markets, to maintain commodity quality, retain quarantine integrity and assure food security. However, resistance in target insect pests, out of date fumigation standards, and poor fumigation practice have contributed to many control failures costing millions of dollars in remedial treatments and physical losses.

Fumigation standards: Results of surveys undertaken by officers of the Plant Protection Department reveal that, although not common, strong resistance to phosphine is present in some species.

Resistance was further characterised using specialised flow-through equipment and times to population extinction established for strongest resistant strains. Field trials have also been undertaken in rice storages, all of which will form the basis for updating Vietnam's phosphine fumigation standard.

Resistance to phosphine in Liposcelis spp.: Psocids (*Liposcelis* spp.) have become major pests of many stored durable commodities in Vietnam. These insects proliferate rapidly and have become a threat to Vietnam's export trade and domestic storage system. Officers at the Plant Protection Department, Hanoi, have undertaken a survey of psocid populations in central storages belonging to the Department of National Reserve. They found that *L. entomophila* and *L. bostrychophila* are the major pest species. These strains are currently being tested for resistance to phosphine. Results to date reveal that resistance is present in all strains of *L. bostrychophila* while none of the strains of *L. entomophila* tested showed resistance. One strain of *L. bostrychophila* showed a level of resistance stronger than that seen in the most resistant strains of other pest (e.g. beetle) species.

Training needs: Discussions have taken place with the Dept of National Reserve to identify training needs and a training plan is being developed in cooperation with the Plant Protection Department.

Decrease losses to stored food suffered by farmers by researching and extending improved household storage techniques: Maize is the staple food of people living in mountainous regions of northern Vietnam. A major problem for them is the loss of 20-40 per cent of production after harvest due to mould and insect contamination. Officers of Vietnamese Institute for Agricultural Engineering and Post Harvest Technology (VIAEPHT) successfully developed a horizontal dryer for batches of 500-1000 kg maize. These machines will dry the grain from 22 per cent moisture content to <14 per cent in 6-7 hours resulting in significantly reduced mould, mycotoxin and insect contamination. Trial results showed that grain could then be stored successfully for 4-5 months. Such equipment is unaffordable for many mountain farmers but units are being acquired by farmers in the more prosperous coastal districts.

In mountainous regions, corn is commonly stored on the cob in lofts of village households. This practice was previously adequate for storage of traditional low-yielding maize varieties. However, since the introduction of high-yielding hybrids, losses suffered in storage using this method are typically about 20 per cent. VIAEPHT showed that a mobile stove can be used to effectively dry the corn in 10-12 days. This innovation is affordable and compatible with village life and results in lower and more uniform moisture content and a reduction in losses to about 5 per cent. VIAEPHT officers also developed double cover bags that will store corncobs, once dried, in good condition for up to 6 months.

The VIAEPHT project team delivered 4 training courses, each for about 70 farmers, in the mountainous provinces of Nghe An and Thai Nguyen. Topics covered: insect pest detection and damage, results of field trials, use of practical, effective cleaning, drying and storage methods. Officers of VIAEPHT have also produced a practical IPM manual for farmers.

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

Overseas Collaborating Countries	China
Commissioned Organisation	University of Sydney, Australia
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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	$868,982
Project Duration	01/01/2002 to 30/06/2005
ACIAR Research Program Manager	Dr Greg Johnson

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 post-harvest 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 post-harvest 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 post-harvest 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. 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 is examining these to improve post-harvest disease control, handling and market quality of melons and other cucurbits, and improve returns to growers in China and Australia.

Project progress

Year 3 (01/01/2004-31/12/2004)

Develop pre-harvest strategies which boost natural defence mechanisms in melons, control disease and maintain quality: Field trials of Systemic Acquired Resistance (SAR) elicitors were screened in glasshouse trials and tested under field conditions in both Australia and China, to confirm their efficacy in controlling pre- and postharvest disease. Treatments were assessed for effects on the development of pre-harvest disease and postharvest disease during transport and/or storage regimes. Biochemical changes, such as enzyme activities of pathogenesis-related proteins, levels of antifungal compounds, and the production of volatiles, were examined in some experiments, as indicators of SAR induction, and may help explain enhanced resistance following SAR induction.

Fruit yield and quality: No treatment effects on physiological parameters were detected, although some symptoms of phytotoxicity were recorded on treated plants in one trial after ReZist application at the highest concentration (88ppm). Treatments had no apparent effects on fruit yield or sugar content. In one Xinjiang trial, SAR-treated fruit generally tended to have higher sugar levels, which may have reflected healthier foliage and greater photosynthetic capacity; however data to support this were limited. SAR treatments had no apparent effects on the marketability of fruit in the Chinese trials.

Combined SAR elicitor and fungicide: Pre-harvest SAR/postharvest fungicide combination treatments were tested in the Minqin storage and transport studies, one Xinjiang transport study, and in storage experiments at Sydney Postharvest Laboratory. BTH/azoxytrobin combined treatment reduced the severity of postharvest disease on fruit in the Minqin storage study, but there were no significant differences between treatments in postharvest disease on fruit in either transport study.

Develop and test postharvest technologies which can be used during storage and transport to minimise disease and improve quality: In the Chinese field trials, fungicides were tested as either sole treatments or in conjunction with pre-harvest SAR applications, and assessed for effects on pre- and postharvest development of disease. Azoxystrobin (Amistar) was applied as a pre-harvest spray in the Xinjiang trials, and as a postharvest dip in the Minqin field trial. Results from the Xinjiang trials indicate that pre-harvest fungicide treatment reduced the severity of powdery mildew and bacterial spot infections on leaves.

In vitro and *in vivo* screening of the fungicides prochloraz (Sportak), iprodione (Rovral) and azoxystrobim (Amistar) were conducted at China Agricultural University. Combining fungicide dips with heat treatment generally increased the suppression of disease development. *In vivo* testing of the fungicides imazalil, kresoxim-methyl, azoxystrobin, and imazalil/azoxystrobin combinations were conducted at Gansu Agricultural University. The fungicides were applied as postharvest dips, and some treatments were combined with hot water dipping. The results indicated that all of the fungicide treatments reduced the severity of *Trichothecium* sp. and *Fusarium* sp. rots, with the best disease control from imazalil and imazalil/azoxystrobin combined treatments.

Transport studies – Urumqi to Shanghai, Lanzhou to Beijing: A study of Hami melon transported by train from Xinjiang to Shanghai and of honeydew melon transported by truck from Minqin, Gansu to Beijing was completed during the 2004 season. Postharvest disease development was assessed upon arrival at the destination and during subsequent storage at ambient temperature. Shipments were also monitored for temperature, humidity, and vibration impact (Minqin study only) during transport. Poor conditions during transport, exacerbated by fruit over-maturity led to rapid disease development, and may negate the capacity of SAR and postharvest treatments to control disease.

Assess small-scale postharvest technology for Chinese melon industry: Two extension workshops were held in Wu Jia Qu and a third in Shanshan, Xinjiang with farmers, wholesalers, extension officers and researchers, in order to develop a better understanding of supply chain issues and feasible improvements that can be made along the supply chain. Farmers expressed interest in some of the technology discussed; however the fragmented and transaction-based nature of the supply chain is a major impediment to adoption of technology, as farmers/wholesalers must be able to realise benefits of improved fruit quality and shelf-life beyond their immediate transaction. Also, the lack of stable land tenure in the Military Farm system means that the allocation of land changes from one season to the next, and there is no incentive to invest in infrastructure.

Use supply chain assessment and cost benefit analysis of potential innovations as drivers of technological adoption in entrepreneurial decision making in melon production and marketing: A consumer focus group was held at Jiao Tong University, Shanghai, and a consumer survey of over 200 cases was completed in selected venues, including three universities and a multinational company. The results indicated that there was a good but underdeveloped market for Hami melon in Shanghai, supermarkets are a growing market sector, consumers prefer to store Hami melon for three or more days at ambient temperature, supplying full maturity melons that are sweet with no defects will increase sales and demand, and that poor consumer knowledge meant that product differentiation, better marketing, and consumer education will be important to compete with other provinces and imports.

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

Overseas Collaborating Countries	China
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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	$717,773
Project Duration	01/07/2004 to 30/06/2007
ACIAR Research Program Manager	Dr Greg Johnson

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. 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 are being developed.

Project progress

Year 1 (01/07/2004-30/06/2005)

Analysis of production and handling systems to determine risk factors leading to spoilage and contamination, and *Improved monitoring of human pathogen contamination risks during fresh vegetable handling and marketing*: Chinese and Australian partners collaboratively conducted process audits of four fresh vegetable supply chains in the Beijing area. These audits mapped the process flow from production to retail, identified the human and plant health hazards, the control points and the verification steps practised. Steps requiring investigation and/or improvement were identified.

Following the process audit, researchers from the China Agricultural University began a microbiological contamination audit on three types of fresh vegetables (pak choi, carrots and tomato)

from these supply chains. The audit consisted of sampling vegetables at harvest, during washing and at retail and also sampling from five environmental sources (soil, organic fertiliser, irrigation water, wash water before use and used-wash water). Tests are determining the total plate count, E. coli/coliform counts and enterococci populations in the samples. In addition, the presence/absence of pathogens (*Salmonella* and *Listeria monocytogenes*) will be determined on the products at retail.

CAAS scientists have completed experiments to investigate the influence of cultivar, inoculum concentration (*Erwinia carotovora*), packaging, temperature and time on the incidence and severity of bacterial soft rot of pak choi and carrot. An experiment is planned for the influence of these factors on Botrytis rot of tomato. Tomatoes were planted at the Nankou station of IVF in April to prepare for this experiment.

DPI scientists completed a trial demonstrating a strong influence of plant nutrition on the susceptibility of pak choi to bacterial soft rot. Statistical analysis is pending, however, high levels of calcium in plant tissue have been shown to increase resistance to pathogens, most probably due to its role in strengthening and stabilising the cell wall and membranes, while high rates of nitrogen fertilisation have been associated with decreased resistance. The interaction of these two nutrients can play a part in determining the storage life. Generally high levels of nitrogen lead to very vigorous growth and depressed root development, both of which may lead to lower levels of calcium being distributed to expanding leaves. This is likely to lead to low nitrogen and high calcium treatments being more disease resistant.

A comprehensive literature review was conducted on *Enterococcus* spp and their significance for fresh vegetables. *Enterococcus faecalis* has a limited host range, being more specific to human, dog and chicken faeces, suggesting *E. faecalis* is an ideal contamination indicator for microbial source tracking. A collection of presumptive enterococcal cultures has been isolated from fresh pak choi obtained from supermarkets in Melbourne. A genetic database search has identified up to three regions within the 16S rRNA gene unique to *E. faecalis* and appropriate PCR primers have been developed. A PCR system targeting a region of the 16S rRNA gene has been established for the specific detection of *E. faecalis*.

Project ADP/2002/114: Rural poor and smallholders in western China under WTO: A regional and community level analysis

Overseas Collaborating Countries	China
Commissioned Organisation	International Food Policy Research Institute, USA
Project Leader	Dr Shenggen Fan Phone: 1 202 8625677 Fax: 1 202 4674439 Email: s.fan@cgiar.org
Collaborating Institutions	Chinese Academy of Sciences, Centre for Chinese Agricultural Policy, China Chinese Academy of Agricultural Sciences, Institute of Agricultural Economics, China Gansu Agricultural University, College of Economics and Trade, China
Project Budget	$398,929
Project Duration	01/07/2003 to 30/06/2006
ACIAR Research Program Manager	Dr Ray Trewin

Project background and objectives

Since December 2001 China has been part of the World Trade Organisation (WTO). The impact of the Chinese economy as a whole will be positive, but distribution of these benefits across regions and sectors of the economy is likely to be patchy. Sectors and areas engaged in agricultural and other production where China does not have a comparative advantage stand to gain very little or even lose. One area likely to be in this situation is western China, a region that accounts for more than 70 per cent of China's total poor. It is characterised by poor infrastructure and resources and is mainly an agricultural producer. The Chinese government has identified development of this region as a top medium to long-term priority. With WTO accession policymakers will need to re-evaluate current policies to ensure smallholders are not disadvantaged.

Agricultural growth is a key driver of poverty reduction. Policies will need to cater for investment options that help build infrastructure, strengthen outputs and address barriers to smallholders gaining from this by way of increased productivity or migrating to non-farm sectors. Infrastructure, education and health spending is low, entrenching many of the barriers to non-farm migration and current agricultural practices. WTO entry could aggravate this situation unless a clear understanding of its impacts is understood. The project is researching future policy options, particularly public investment policies, for the Western China to achieve both economic growth and poverty reduction and buffer adverse shocks under WTO.

Project progress

Year 2 (01/07/2004-30/06/2005)

The team has finished the literature review and the compilation of secondary datasets. A large data set at the country level on public financing and expenditure from 1993 to 2002 from various sources was completed. The dataset on agricultural production and inputs at the county level has also been updated. A report has been written and a discussion paper has been published.

In addition, a census type of household survey (i.e. all households in the village) for three villages has been conducted in Guizhou Province. Two reports have been prepared and presented in several national and international conferences using the surveyed data.

The township/village surveys in Gansu Province and Guizhou Province are underway. The team has visited the two provinces several times to test the questionnaire and trained the enumerators in late

2004 and early 2005. The large scale survey started in June 2005 and by the end of July the project finished more than half of the villages in Guizhou and more than two thirds in Gansu.

For each province, more than 20 student enumerators and three faculty members are involved. The survey is expected to be completed by the end of August, 2005, and the data entry by October 2005. Afterwards, the team will begin to analyse the surveys and prepare the reports and publications.

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

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 31/12/2006
ACIAR Research Program Manager	Dr Ray Trewin

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 (TBT) – 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 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 1 (01/07/2005 to 30/06/2006)

The first progress report is due in 2006.

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

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 Chinese Academy of Sciences, Centre for Chinese Agricultural Policy, China World Bank, USA National Council of Applied Economic Research, India
Project Budget	$590,208
Project Duration	01/06/2005 to 30/06/2008
ACIAR Research Program Manager	Dr Ray Trewin

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 knowledge, science and technology (KST) based on the analysis of alternative development paths and their implications for food security, rural development, and environmental sustainability.

Project progress

Year 1 (01/06/2005 to 31/05/2006)

The first progress report is due in 2006.

Project ADP/2005/041: Trade and agricultural development in developing countries — China, India

Overseas Collaborating Countries	China, India
Commissioned Organisation	International Food Policy Research Institute, Market and Structural Studies Division, USA
Project Leader	Dr Ashok Gulati Phone: 1 202 862 5600 Fax: 1 202 467 4439 Email: a.gulati@cgiar.org
Collaborating Institutions	No collaborators
Project Budget	$150,000
Project Duration	01/06/2004 to 31/12/2005
ACIAR Research Program Manager	Dr Ray Trewin

Project background and objectives

Assessing agricultural policies and levels of protection or disprotection for selected Asian developing countries, particularly India and China, since the inception of the WTO Uruguay Round negotiations in 1985, will help refine approaches to ensuing WTO benefits agriculture. The conceptual and empirical issues that arise when calculating such measures as market price support (MPS) or producer support estimates (PSEs) for developing countries need to be more clearly understood. Two reports have been produced (Mullen, Orden and Gulati, Agricultural policies in India: PSEs 1985-2002, http://www.ifpri.org/divs/mtid/dp/papers/mtidp82.pdf; Cheng and Orden, Exchange rate misalignment and its effects on agricultural PSEs: empirical evidence from India and China, http://www.ifpri.org/divs/mtid/dp/papers/mtidp81.pdf).

The results presented in the two papers have increased knowledge about the policies that have caused protection or disprotection of agriculture in India and China, and the magnitudes of these effects. The results have been presented at conferences in China, Pakistan, at FAO, and at meetings of the American Agricultural Economics Association, and will be presented in other professional settings and in discussion with policy-makers.

Project progress

Year 1 (01/06/2004-31/05/2005)

The report on agricultural policies in India reviews the substantial economic policy reforms undertaken since 1991. The protection and support versus disprotection of agriculture have been evaluated by examining market price support for eleven crops (accounting for nearly half of agricultural production value) and budgetary expenditures for fertiliser, electricity and irrigation subsidies. Key domestic and international cost adjustments are incorporated into the analysis by drawing on the extensive price-comparison data sets and assessments developed previously often using disaggregated analysis for representative surplus and deficit states.

Our results indicate that support for agriculture in India has been counter-cyclical. Support for agriculture rises when world prices are low (as in the late 1980s and 1998-2002) and falls when world prices strengthen (as in the early and mid 1990s). Budgetary payments (for input subsidies) have increased in recent years. Yet for key commodities and in the aggregate, when incorporating both price support and budgetary expenditures, the counter-cyclical dimension of agricultural policy dominates a clear trend from disprotection toward protection over the period 1985-2002.

The counter-cyclical pattern of support for agriculture in India has an important interpretation in the context of the WTO Doha Round agriculture negotiations. India has used border protection to insulate its farmers from low world prices in a manner and timing that corresponds to the increased subsidies provided in the United States and other developed countries when world prices fall. Disciplines on both of these instruments will be required to achieve an agreement that is effective at increasing world trade opportunities and stabilise world price levels.

The magnitudes of estimated support for agriculture obtained are important for several additional reasons. The estimates confirm that high levels of subsidies (in the range of 35-50 per cent) were required for India to export wheat or rice in recent years, a conclusion reached by several other studies. However, less disprotection of Indian agriculture in the 1990s was reported than in earlier published studies. Part of this difference is explained by the differences in approach, like the modified procedure for choice of a reference price. A large component of this difference can be accounted for by whether or not the scaling up procedure is invoked.

In the second paper, on exchange rate misalignment and its effects on producer support estimates, modem time series econometric techniques are used to identify determinants of the equilibrium real exchange rates for India and China. Findings show that, due to poor external sector performance and depletion of foreign exchange reserves, the actual real exchange rate of the Indian rupee was overvalued in the years leading up to the financial crisis in 1991, but has since then move closer to the equilibrium. The Chinese yuan also experienced periods of misalignments which mostly consist of undervaluation. Rigid nominal exchange rates, low inflation rates, and strong economic fundamentals in recent years have driven up the gap between the actual and equilibrium value of Chinese currency, causing an undervaluation of about 20 per cent.

The nominal equivalents of the equilibrium real exchange rates are applied to the calculations of market price support and producer support estimates to determine the effects of exchange rate misalignment on agriculture. Drawing on the India study, and initial work on the agricultural policies in China by Dr. Dongshen Sun of CASS, results (from 1986-2002 for India and from 1995-2001 for China) show that the “indirect” misalignment effects have either amplified or counteracted the direct effect on agriculture from sector-specific policies. In India, such indirect effects are relatively small, especially after the 1991 economic reforms, and are mostly dominated by the direct effects. But in China, especially in recent years, the indirect effect from exchange rate undervaluation has been quite substantial. From 1999-2001, for example, it is estimated that direct effects of agricultural policies resulted in average disprotection of agriculture measured by commodity- specific producer support estimates of -7.7 per cent, while the indirect effect of undervaluation was +10.2 per cent.

The results presented in these two papers increase knowledge about the policies that have caused protection or disprotection of agriculture in India and China, and the magnitude of these effects. These results, along with analyses we have developed for Indonesia and Vietnam, have been presented at several conferences, including two in China (in Beijing, December 2003, and Nanjing, December 2004, each publishing a conference proceedings); one in Pakistan (March 2005); at the FAQ (October 2003); and at two annual meetings of the American Agricultural Economics Association (August 2004 and accepted for July 2005).

Project LWR/2000/030: Growing more rice with less water: Increasing water productivity in rice-based cropping systems

Overseas Collaborating Countries	China
Commissioned Organisation	International Water Management Institute, Sri Lanka
Project Leader	Randolph Barker Phone: 94 1 867404 Fax: 94 1 866854 Email: R.Barker@cgiar.org
Project Web Site	http://www.clw.csiro.au/research/agriculture/irrigated/help/ ; http://www.irri.org/ipswar/about_us/ipswar.htm
Collaborating Institutions	CSIRO Land and Water, Australia Wuhan University of Hydraulic and Electric Engineering, China International Rice Research Institute, Philippines
Project Budget	$908,357
Project Duration	01/07/2001 to 31/12/2005 (Project extended from 01/07/2005 to 31/12/2005)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Because a large part of the Chinese population depends on rice production, China is promoting water-saving irrigation (WSI) techniques such as alternate wetting and drying instead of the traditional method. Field experiments in China have shown that in most of the rice cropping systems WSI does not reduce the yield of the rice, but reduces the irrigation input by about 10–15 per cent compared to continuous flooding. This has led to questions about the nature, success, and adaptability of the alternate wetting and drying technique, and how it can be transferred to other areas. Australia is facing problems similar to those of China. The declining water availability, increasing water prices, and environmental degradation of agricultural lands and riverine ecosystems are driving the demand for water savings.

Past research has indicated that there is a potential to save irrigation water by using alternate wetting and drying and saturated soil culture. However, because these techniques lead to changes in irrigation demand, the potential benefits to river flow patterns have yet to be determined. This collaborative project between Chinese and Australian laboratories aims to promote water management techniques in rice-based irrigation systems that reduce water consumption and do not decrease crop production. In particular this project aims to further investigate the technique of alternate wetting and drying, and to compare it to the techniques of saturated soil culture and aerobic rice in China.

Project progress

Year 4 (01/07/2004-30/06/2005)

Zhanghe in Hubei Province: Field trials were conducted by toposequence comparing partially rainfed rice (no irrigation after stand establishment) with irrigated rice. The results suggest the opportunity for growing rainfed rice and saving water in the lower toposequence positions and the need to apply water in the other toposequence positions.

Based on the satisfactory performance of ORYZA 2000, scenario analysis with historic weather data (1989–2002) was carried out with four water management strategies and two soil types with different saturated conductivity. Water balance components, evaporation, transpiration, and percolation as well as grain yield were computed for each water regime at depths of 20, 60, and 100 cm.

A fully functional prototype of the OASIS model is now ready for use. This prototype includes key features such as storage at three different levels (from field to main system) and detailed irrigation/delivery scheduling options. The prototype can accommodate upland, lowland, and natural vegetation such as forest.

In connection with the OASIS model a survey was conducted of farm ponds in four villages. The objective was to determine how the decline in ZIS water for irrigation affected farm pond utilisation. The survey results revealed that there had been a steady increase in number of ponds and improvement in existing ponds in response to the reduction in irrigation water from ZIS. It was also noted that farmers adopted alternate wetting and drying in response to water shortage.

Liuyuankuo in Henan Province: Field experiments were continued on crop management of aerobic rice. The results suggest that in years of high rainfall aerobic rice can be grown without irrigation. However, the tested aerobic rice variety does not seem to suit the study site. Nitrogen and density management did not improve yield.

The ORYZA 2000 model was calibrated and evaluated for both aerobic and inbred varieties. With to soil water balance models (PADDY and SAWAH) against four years data (2001-2004) from field experiments. The model performed satisfactorily under both continuous flooding and water saving irrigation allowing several scenario simulations to be run. Using the hydrologic-economic model the following scenarios are being studied and finalised:

- present hydrologic conditions,
- no irrigation supplies from the Yellow River – Yellow River Seepage and groundwater pumping only,
- lining of canals with shifting of surface water below the railway line,
- lining of canals with surface water supplies above and below the railway line,
- options to reduce fallow evaporation losses from shallow water tables above the railway lines, and
- a matrix approach is being used to evaluate each of the above scenarios with four cropping options.

In conjunction with the modelling effort described above a survey was conducted to:

- determine the role of pumps and estimate the cost of extracting ground water,
- calculate the gross margins of rice and other crops, and
- estimate the cost of canal lining.

The cost of water extraction depended on the number of irrigations, hours of pump use, and type of pump. Cotton was found to be the most profitable crop followed by rice. The cost of canal lining a branch canal with a concrete thickness of 0.1 metres is around 50 yuan per square metre.

Murrumbidgee Catchment (Australia): The CSIRO project team in Australia was able to access additional funding through the Pratt Water Project in the Murrumbidgee Valley. This helped carry out additional water savings and hydrologic analysis and to apply the Murrumbidgee surface-ground water interaction model developed under the ACIAR project to quantify and upscale water efficiency.

Concluded projects

at 30 June 2005

Bilateral

Multilateral

Project AS2/2001/029: Development of a knowledge system for the selection of forages for farming systems in the tropics

Overseas Collaborating Countries	China, Global, India, Indonesia, Pakistan, Philippines, South Africa, Vietnam
Commissioned Organisation	CSIRO Sustainable Ecosystems, Australia
Project Leader	Dr Bruce Pengelly Phone: 07 3214 2348, 0418 720 364 Fax: 07 3214 2308 Email: Bruce.Pengelly@csiro.au
Collaborating Institutions	Queensland Department of Primary Industries and Fisheries, Australia International Livestock Research Institute, Ethiopia International Centre for Tropical Agriculture, Colombia University of Queensland, Australia Global Overseas Collaborators, Global
Project Budget	$837,717
Project Duration	01/07/2002 to 30/06/2005
ACIAR Research Program Manager	Dr Bill Winter

Project background and objectives

The demand for livestock products is expected to double by 2020. Smallholder farmers in developing countries, through more efficient and productive farming, will be able to benefit from this increase in demand. One way to achieve this is through planting well-adapted forages. However, it is often difficult for people in developing countries to identify and obtain the best possible forage. At present, much of the important information is fragmented, unpublished or published in media of limited circulation. A database is needed to capture the accumulated knowledge in a form that is applicable to all farming systems in the tropics.

The aim of this project is to develop a database that will help smallholder farmers in the tropics to select the best possible forage for their situation. The Selection of Forages for the Tropics (SoFT) database will allow smallholders to improve their productivity and thus benefit from an increasing demand for livestock products.

Project outcomes

This project accessed he best available information for adaptation and use of 180 tropical forage species and their elite cultivars integrated in a single user-friendly database. The database, which includes a simple-to-use tool to assist in the selection of the best-bet species, is now freely available on the Internet (www.tropicalforages.info) and on CD.

The database has five main features:

- information in fact sheets on the adaptation, uses and management of forage species, cultivars and elite accessions;
- a selection tool built on LUCID that enables easy identification of best-bet species;
- a bibliography of more than 6,000 references and abstracts on forage diversity, management and use which will enable users with poor library facilities to access summaries of some of the key literature;
- global maps of climate adaptation for each species; and
- a collection of photographs and images of species to help in their identification and use.

The database selection tool is an expert system based on the experiences of forage specialists who have worked for many years in tropical and subtropical regions of Africa, lower latitude USA, Central

and South America, South and South-east Asia and Australia. Selections were made on the basis of 19 criteria. The project brought teams of experts together in workshops in Africa, Asia, South America, Central America, Europe and Australia over a two year period and had input from other forage specialists during the database development.

The principal outcome summarised information on tropical forage adaptation and use from expert knowledge, available literature and experiential sources made available in a readily accessible and consistent format. With availability on DVD and the Internet, the database allows researchers and advisors to select those forages most suitable for local conditions. Although the database was initially designed for use in developing countries, its content includes species adapted to farming systems in developed countries and is equally applicable in these regions. The database covers a wide range of forage uses and allows users to select among many different farming systems ranging from permanent to short term pastures, with applications in agroforestry, inter-row cropping, cut-and-carry, hedgerows, green manures and ground covers.

The database has been recognised as a valuable teaching tool for colleges and universities with feedback from many university staff from a wide range of countries attesting that the database and selection tool will have a major role in improving the way tropical forage science is taught.

The database was promoted during regional workshops, through partner organisations including CIAT and ILRI. The project team also conducted database demonstrations at the XX International Grassland Congress, held in Ireland in June 2005. Over 100 tropical forage agronomists trialled the selection tool and fact sheets. FAO became included in the project's partnership and agreement after discussions over the past 3 years. Involvement with FAO will further promote awareness of this database internationally.

The database resides on the CIAT Internet server and where it is maintained and updated. After a few months a need for information to be added to the fact sheets was identified and requests for additional funding have been made. CIAT is also exploring possibilities for the database to be translated into Spanish to encourage application in Latin America and the Caribbean.

Project ASEM/1998/060: Chinese wool textile mills: economic analysis of fibre-input/textile-product selection and new processing technologies

Overseas Collaborating Countries	China
Commissioned Organisation	University of Queensland, Australia
Project Leader	Dr Colin Brown Phone: 07 3365 2148 Fax: 07 3365 9016 Email: Colin.Brown@uq.edu.au
Project Web Site	http://www.nrsm.uq.edu.au/Nrsm/AgEcon/research/chinaP/Chinamenu.htm
Collaborating Institutions	Research Centre for Rural Economy, China
Project Budget	$699,622
Project Duration	01/01/2001 to 31/12/2004 (Project extended from 01/01/2004 to 31/12/2004)
ACIAR Research Program Manager	Dr Ken Menz

Project background and objectives

China has the largest wool textile industry in the world, contributing 80 per cent of the growth in world wool consumption in the 1980s. However, recent economic reforms and market developments have posed major challenges to the viability of most Chinese wool textile mills. The mills are under pressure to become more competitive, to introduce better enterprise management and to improve their environmental standards. Yet in many cases there is a lack of both the decision tools and skills needed to improve management practices.

Understanding the different impacts on mill profitability, for example, has the potential to improve dramatically mill pricing strategies for their outputs and purchase strategies for their fibre inputs. There is also a need to introduce improved scouring efficiency and discharge systems to meet new environmental standards. China is Australia's largest market for raw and semi-processed wool, accounting for one quarter of Australia's wool exports. In 1997, some 53 per cent of China's wool imports came from Australia. Wool and wool textiles are also the major trading items between China and Australia. These statistics emphasise the economic importance of the continued viability of the Chinese textile industry to both China and Australia.

The overriding goal of this project was to improve the long-term viability of Chinese wool textile mills through adaptation to the changing market and policy environment and improvement to the efficiency of operation. The project aimed to improve mill viability through its recommendations on mill fibre-input/textile-product selection and effluent treatment technologies.

Project outcomes

The 'core' component of the project — the development of a wool textile mill management model — demanded access to large amounts of internal mill data that was both very commercially sensitive and time-consuming to collate and prepare. Development of the model was made possible because of the goodwill built up with collaborating mills and industry organisations. On this basis, the research team built the CAEGWOOL mill management model. Capturing the complexities of mill processes within a model usable across China proved to be highly demanding from both analytical and programming perspectives. The model was calibrated in mills in China which, by the end of the project, reported that from its application they were producing robust results that closely reflected actual mill operations.

The model was extended to managers from a broader group of around 15 worsted mills and other industry officials at a training workshop in Wuxi City in June 2004. They learned to use the model in an interactive way, and in connection with a series of papers and talks about management systems and analytical approaches. Questionnaires conducted at the workshop indicated that the mills will use the management tool and/or the management approaches to complement existing decision-making

practices. The model was subsequently presented at the International Wool Textiles Conference, attended by all major industry officials and senior staff from hundreds of Chinese wool textile mills. The interest in the model, and encouragement for its further dissemination across the industry generated at this Conference, has seen the Chinese research team seek funding from Australian Wool Innovation Ltd. to further develop and disseminate the model.

Measures are now being undertaken to move from a 'research' to a 'commercial' model and to transfer all knowledge to a Chinese organisation that will pro-actively target a large proportion of the hundreds of wool textile mills in China, teaching them to use the model. This more 'scientific' management tool promises to make a significant contribution to the management and, ultimately, the viability of Chinese wool textile mills that are the dominant customers for Australian wool.

Amongst many publications arising from the project are the following major 'flagship' publications, each of which targets a specific audience:

- an ACIAR technical monograph that includes the 'research model' itself, the manual for its use, and a range of supporting technical documents (published bilingually in Chinese and English and made widely available in China),
- a book entitled *Modernizing China's Industries: Lessons from Wool and Wool Textiles*, written by the Australian members of the research team, and
- a book entitled *The Chinese sheep industry – markets, trade and industry organisation*, written by the Chinese members of the research team.

Through these and previous project activities and publications, the research team has become highly visible in industry activities in both China and Australia. Chinese members of the research team are now regularly invited to deliver presentations on wool textiles and the Chinese sheep and wool production and marketing systems. At the same time, Australian team members have provided advice on developments in the Chinese wool and wool textile industries to industry groups in both Australia and China.

The consistent message conveyed through these forums is that the Australian and Chinese wool industries are complementary rather than competitive, and that there are various measures that can improve the flow of Australian wool to China and the way that Chinese mills use that wool. The Chinese wool textile industry needs to become more pro-active and turn attention to improving management practices, and to improve co-ordination between industry sectors.

In December 2004 and January 2005, the Australian research team prepared two detailed briefs for Australian Wool Innovation Ltd. about Chinese wool production, marketing, and supply chains. These two reports, together with a much shorter set of *Notes* prepared for a National Farmers Federation delegation visiting China, were used to inform Australian industry leaders about the domestic wool industry in China, and to brief Australian government officials preparing for the negotiations surrounding the China-Australia Free Trade Agreement.

Project FST/1996/125: Development of germplasm and production systems for cold tolerant eucalypts for use in cool regions of southern China and Australia

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Dr John Doran Phone: 02 6281 8319 Fax: 02 6281 8312 Email: john.doran@csiro.au
Collaborating Institutions	Forestry Tasmania, Australia China Eucalypt Research Centre, China Fujian Forestry Department, China Yunnan Academy of Forestry, China Centre for Forest Tree Technology, Australia Guangxi Forest Research Institute, China
Project Budget	$928,522
Project Duration	01/01/1999 to 31/12/2004 (Project extended from 01/01/2003 to 31/12/2004)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Eucalypts are of considerable economic, social and environmental importance in southern China. In 1995, eucalypt plantations accounted for about 670 000 ha and eucalypts were also used in plantings beside roads, canals, villages and homes. Rates of planting have increased but, nevertheless, parts of the country face an impending wood deficit as demand grows. The projected deficit is particularly acute in the provinces of the southern central region. These provinces also face other forestry and environmental problems. Large areas lie in the red soils region, where the combination of deforestation, ready soil erodibility and inappropriate land uses has led to serious environmental degradation.

The Chinese people view expansion of plantation forestry as a way of addressing many of the environmental problems in the region, while improving local incomes and providing needed forest products. But attempts to use native species, such as Chinese fir and Yunnan pine, have been unsuccessful in the red soils region. In contrast, some eucalypt species and provenances are known to display fast growth in many of China's poor soils. But most eucalypts have been planted in China in the warmer parts of the country, not in the cooler areas of south central China where the most degraded land occurs. The existing eucalypt germplasm in China was limited, and far less suitable, for these areas than specially-adapted provenances.

Plantation eucalypts suited to mean annual temperatures of 15-20°C, with absolute minimums down to -8°C existed in Australia, but provenances needed defining. China also needed to develop expertise and silvicultural technologies for these eucalypts, while Australia would also benefit from greater knowledge of cold-tolerant eucalypts. The main aim of the project was to improve the use of eucalypts in the degraded cool highlands of southern central China by testing provenances and developing suitable seed orchard techniques to help establish more productive local plantations there.

Project outcomes

Evaluation of existing trials and establishment of supplementary trials: scientists collated historical data from 34 trials in China and seven in Australia, then reassessed 17 of the Chinese trials and six of the Australian trials. Ten supplementary species/provenance trials were established in China, signifying an important contribution to germplasm in the region. *E. nitens* provenance trials were assessed and analysed for growth and wood property traits. Local scientists received training in assessment, data management and analysis of field trials.

Site evaluation: An important shift in direction of this sub-project from a landscape focus to one of individual site/growth relationships occurred in 2001. This followed on from the attendance of three Chinese scientists at a 15-day soil description and site evaluation course in Tasmania and Victoria in October 1999. Australian scientists reinforced the principles with significant 'in-field training' during the visits to China, but the Chinese institutions there have been slow to adopt the methods.

Genetic resources: Problems with obtaining access to the 1990 breeding population of *E. globulus* hampered progress. Breeding plans were written for *E. globulus, E. maidenii* and *E. smithii* in Yunnan, and for *E. dunnii* in Guangxi. The 1995 trials of *E. smithii* planted in Yunnan were selectively thinned as part of the project. New breeding populations of *E. globulus* and *E. maidenii* were established in Yunnan and new multiple-site breeding populations of *E. camaldulensis* and *E. saligna* were established in Fujian. The project made a significant contribution of new germplasm, which the participating Chinese institutions planted in well structured populations.

Eucalyptus phenology and seed productivity: Flowering trials of four species (*E. nitens, E. dunnii, E. smithii* and *E. globulus*) were established on various sites. Poor flowering was identified as the major limitation to the genetic improvement of *E. dunnii.* An Australian study will hasten progress with advanced seed orchard management.

Silvicultural Practice: These were reassessed for *E. nitens*, with spacing trials in Tasmania, leading to thinning treatments in one trial. Forestry Tasmania completed a series of pruning trials on *E. nitens* and *E. globulus*. Two new silvicultural trials were established in Yunnan, and Hunan was scheduled to establish at least two new silvicultural trials in 2003. A new thinning trial was established in Tasmania. The work highlighted a need for comprehensive research on stand management silviculture in China and Australia.

Project FST/1999/042: Growth stresses in eucalypts: evaluation and development of measurement techniques

Overseas Collaborating Countries	China
Commissioned Organisation	CSIRO Forestry and Forest Products, Australia
Project Leader	Dr Geoff Downes Phone: 03 6226 7962 Fax: 03 6226 7901 Email: geoff.downes@csiro.au
Collaborating Institutions	Chinese Academy of Forestry, China Queensland Forest Research Institute, Australia
Project Budget	$149,998
Project Duration	01/07/2002 to 31/05/2004 (Project extended from 01/01/2004 to 31/05/2004)
ACIAR Research Program Manager	Dr Russell Haines

Project background and objectives

Strain forces generated in the release of growth stress in eucalypt species can result in serious distortion and quality degradation in sawn timber. They are a major constraint to use of plantation-grown eucalypts for high-value products such as construction, joinery and furniture.

Many developing countries have now established large areas of eucalypt plantations that are in use for fuelwood, pulp and poles. These plantations could yield higher-value products if wood quality problems including growth stresses could be solved. The plantation industry needs a reliable, efficient and non-destructive method of predicting growth stress in standing trees and in logs prior to processing, in place of existing methods that are slow and cumbersome and produce less than satisfactory results.

This project aimed to develop such methods whereby research and industry could rapidly and accurately screen large numbers of trees or logs and reliably classify them for severity of growth stress.

Project outcomes

Based on the evaluation of the utility characteristics, the CIRAD-fort method was recommended for routine field growth strain assessment and the strain gauge method for scientific research. Strain correlated significantly between the three methods tested. The strength of the relationships indicates that strain by one method could be estimated from another with reasonable confidence. This in turn indicates that the three methods are compatible in segregating trees into similar broad strain classes.

In the investigation of faster and less destructive alternatives to measure or predict growth strains in trees or logs the team collected high resolution SilviScan data, NIR spectrum and digital images from *E. globulus* wood specimens that were closely matched with the locations where growth strain was measured. Drilling resistance data were also obtained using a digital microprobe (DmP) at zones beside and above growth strain measurement locations in 22 *E. globulus* trees that represented a wide range of the CIRAD-method displacement measurements.

Based on the results, SilviScan was deemed capable of prediction of growth strain near tree surface with a moderate level of accuracy. As the use of SilviScan technology is becoming more popular, people may use the methods in this report to predict surface growth strain of *E. globulus* from microfibril angle (MFA) when accuracy is not critical or growth strain measurements tools are unavailable.

Results indicated the potential of NIR analysis in predicting the longitudinal strain. Further research is highly recommended to improve the calibration, since NIR analysis has the advantage that its

specimen collection causes little injury to tree stems and also scan spectra may be used to predict a number of other wood properties.

The digital image correlation method was not found reliable in this study because of poor quality images, largely due to inconsistent photograph settings when outside the laboratory environment. The difficulty of obtaining quality digital photos means that the method does not appear suitable for routine growth strain assessment in the field. It could be useful in fundamental research on growth stress, but much more research is needed before this method will be ready for growth strain measurement.

The digital microprobe showed potential for an approximate, quick and low-stem-injury prediction method of growth strain in standing trees. It is portable, user-friendly, low-effort, and cheap to operate. Although it is not designed for accurate predictions of growth strain, it is still worth further investigation as a means of rapid and coarse segregation of lowly stressed trees for sawlogs and for developing procedures for field measurement.

Project LWR/1998/124: Development of technologies to alleviate soil acidification in legume-based production systems in the tropics of Asia and Australia

Overseas Collaborating Countries	China, Thailand
Commissioned Organisation	CSIRO Land and Water, Davis Laboratory, Australia
Project Leader	Ms Suzanne Berthelsen Phone: 07 4753-8534 Fax: 07 4753-8600 Email: Suzanne.Berthelsen@csiro.au
Collaborating Institutions	Queensland Department of Natural Resources and Mines, Australia Chinese Academy of Tropical Agricultural Science, China Khon Kaen University, Thailand
Project Budget	$712,810
Project Duration	01/07/2000 to 30/06/2005 (Project extended from 01/07/2004 to 30/06/2005)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Legumes are widely used in farming systems to improve soil fertility and organic matter accretion through their nitrogen fixation, and to provide protein for human and animal consumption. Some legumes are crops (for example, soybean and peanut), while others are pasture plants (such as *Stylosanthes*) or trees (such as *Leucaena*). *Stylosanthes*, or Stylo, has proved to be an ideal, cheap method of improving the quality of native pastures in Asia, Africa, South America and northern Australia. It adapts well to low-fertility soils and tolerates a range of climate types.

The importance of introduced legumes such as these for increasing the productivity of tropical agricultural systems has long been recognised. However, it is now clear that legumes make the soil more acid. Recent research has shown that acidification has occurred in pastures in Australia's semi-arid tropics following the introduction of *Stylosanthes*. This is also occurring in northeast Thailand, southern China and southern India, at similar rates to those measured in northern Australia. Acidification of soils affects the availability of nutrients to plant roots, by altering the balance of ions.

The soils that have shown the greatest degree of acidification are light-textured, and are characterised by their poor fertility, and inherently small ability to buffer pH changes. Such soils are becoming increasingly important agriculturally (and hence economically). If the soil's organic matter were increased, this would provide greater buffering capacity. Acidity can also be remedied by applying a base, but given the large areas and depth to which the acidity occurs, this would be impractical.

Research is therefore needed to develop production systems that minimise soil acidification and its negative effects. This project will carry out lab and field-based trials in China, Thailand and Australia to help with this.

The main objective of this project was to develop new methods to prevent or limit the damaging process of soil acidification.

Project outcomes

- demonstrated that nitrate-fertilised, deep-rooted grasses can neutralise soil acidity at depth. This finding is particularly significant because neutralisation to depth is rarely possible with conventional approaches using lime.
- demonstrated that applications of materials such as bentonite can be used to restore fertility to degraded, sandy soils in NE Thailand.
- demonstrated that stylo dominance in pastures can be controlled by burning.

Project LWR/2001/001: Improving main system water management in China: A demonstration project in the Zhanghe Irrigation Scheme

Overseas Collaborating Countries	China
Commissioned Organisation	University of Melbourne, Faculty of Engineering, Australia
Project Leader	Associate Professor Hector Malano Phone: 03 8344 6645 Fax: 03 8344 6868 Email: h.Malano@devtech.unimelb.edu.au
Collaborating Institutions	Wuhan University, China
Project Budget	$149,646
Project Duration	01/07/2002 to 31/10/2004 (Project extended from 01/07/2004 to 31/10/2004)
ACIAR Research Program Manager	Dr Ian Willett

Project background and objectives

Irrigation plays a pivotal role in China's plans to meet future food demand. But the volume of water available for irrigation is under threat, largely from the increasing thirst of the country's urban and industrial sectors. In the Zhanghe river basin in China's Hubei province there is strong interest in widespread introduction of water-saving irrigation (WSI) techniques, which can increase food production using less water. But effective introduction of WSI depends on adequate operation of the water supply system.

Similar problems in Vietnam led Australian scientists from Melbourne University to participate in an ACIAR project to study system-wide water management in that country's irrigation schemes. They worked with Vietnamese agencies to adapt a computer model, IMSOP (Irrigation Main System Operation), to analyse and improve operations and develop the infrastructure and institutional arrangements for pricing irrigation supply services. The team also modified and adapted the computer model ASSET MANAGER to speed up collection, retrieval and analysis of asset data.

The project's success caught the attention of the Zhanghe irrigation authorities, who approached the Australians on the team to see if they could undertake a similar study in China. Together they developed this small ACIAR project, designed to improve main system water management in China through a demonstration study in the Zhanghe Irrigation Scheme (ZIS). The project's main objective was to appraise the situation in Zhanghe and modify the IMSOP and ASSET MANAGER models to include features peculiar to Chinese irrigation schemes.

Project outcomes

The project team found that farmers tended to delay their water orders on the expectation that rain would reduce their water bill (which is charged on a volumetric basis). This led to a congestion of orders when farmers all realised their crops were in danger of water stress and therefore submitted their requests within a short period of time. At that point the system was unable to deliver sufficient water for all.

The team modified and adapted the IMSOP model to account for this mode of operation, resulting in the addition of a utility for prediction and sequencing farmer's orders. Other IMSOP modifications came from data collected and processed from the Tuanlin weather station's databases. Through quality checks the team identified and corrected many inconsistencies.

It emerged that changes in the water pricing policy in recent years had led to reduced water demand from farmers and a shortfall in revenues from water fees in relation to cost of water supply. The ASSET MANAGER analysis allowed the irrigation company to calculate actual operational cost of the Fourth Main Canal and develop a sustainable water fee policy.

Wuhan University scientists translated the modified versions of IMSOP and ASSET MANAGER into Chinese and they are now installed on ZIS's computers. China's National Centre for Irrigation and Drainage intends to promote the work at ZIS to other irrigation areas in China. Such guidelines will be vital as the Chinese Government tackles the massive effort to rehabilitate and modernise ailing structures.

By facilitating more widespread adoption of WSI practices the project will also help to address problems of increasing water shortage and competition that are prevalent in vast areas of China, especially north of the Yangtze River. In several regions, the lack of water may limit future economic development.

Project CIM/2000/066: Host resistance, epidemiology and integrated management of faba bean, chickpea and lentil diseases

Overseas Collaborating Countries	Bangladesh, China, Egypt, Ethiopia, India, Iran, Morocco, Nepal, Pakistan, Syria, Turkey
Commissioned Organisation	International Centre for Agricultural Research in the Dry Areas, Syria
Project Leader	Dr Amor Yahyaoui Phone: 963 21 2213433 Fax: 963 21 2213490 Email: a.yahyaoui@cgiar.org
Collaborating Institutions	University of Adelaide, Australia Department of Agriculture, Western Australia, Australia NSW Department of Primary Industries, Australia Agriculture Victoria, Australia
Project Budget	$444,320
Project Duration	01/07/2001 to 30/06/2004
ACIAR Research Program Manager	Mr John Cullen

Project background and objectives

Improved management of faba bean, chickpea and lentil diseases is vital for yield improvement and sustainability in production systems in many developing as well as developed countries. These food legumes (pulses) are an integral and important component of cereal cropping systems, due to their capacity to incorporate atmospheric nitrogen into the soil – a process that benefits the legumes and subsequent crops. Rotation of cereals with legumes also provides a disease, insect and weed break for cereal crops, and reduces the use of pesticides and nitrogen fertiliser.

Over the last decade, new varieties of legume crops emanating from collaborative work between ICARDA and national agricultural research systems in South Asia, China and West Asia/North Africa (WANA) have opened up new cropping areas and increased production. Production has also increased in Australia. However, recent epidemics of certain fungal diseases affecting the leaves of these pulses have led to heavy crop losses. This project brought together experts from around the world to gain a better understanding of the most important fungal diseases of pulses and how to manage them.

The major objectives of the project were to study aspects of the epidemiology of major fungal diseases affecting cool-season food legumes in South Asia, China, WANA and Australia; also to study and characterise the variability of the pathogens causing these diseases and to evaluate legume germplasm and breeding materials with the aim of finding sources of resistance to the above-mentioned diseases. The final objective was to develop and refine integrated disease management technologies then promote their use with farmers.

Project outcomes

The *Ascochyta* pathogen causing blight of chickpea and lentil was known prior to the project, but it was unclear how this pathogen was transferred. Epidemiological studies revealed that the pathogen is harboured on crop stubble left from the previous season, after exposure to cold, moist conditions. Winter chilling requirements for the fungi suggest that cool autumn conditions (below 10°C) will begin this process.

Management control strategies have been developed, in part through computer simulations of different temperature and rainfall interactions. These strategies included spraying with agents to control the pathogen at an earlier time when autumn conditions are colder and suitably moist. Proper crop hygiene and rotation are also important, even when conditions do not favour the pathogen. An

integrated disease management package developed for controlling chickpea *Ascochyta* blight was tested on farmers fields in Syria (through ICARDA), and early results indicate the package is effective.

Several national programs are promoting an *Ascochyta* management package, based on two strategically timed fungicide applications to chickpea varieties with improved resistance. In varietal tests the researchers were able to identify good resistance to most pulse diseases. They also identified lines of faba bean with combined resistance to *Ascochyta* blight, chocolate spot, *Cercospora* leaf spot and some viruses, and chickpeas with resistance to *Ascochyta* blight and vascular wilt. This should lead to the development of new disease-resistant pulse varieties within a decade.

New Kabuli chickpea lines with improved resistance and yield were scheduled for release in 2004 and 2005. Researchers also identified some resistance to Botrytis Grey Mould in lentil. Faba bean varieties with resistance to chocolate spot, *Ascochyta* blight, rust and root rot, and lentil lines with resistance to *Ascochyta* have also been identified in Australian trials. New lines of faba bean resistant to *Ascochyta* blight and chocolate spot have been released, and good levels of wilt resistance were identified in some commercial lines available in Australia. But more work is needed for chickpea.

Projects under development

at 30 June 2005

Bilateral

ADP/2002/092	Free trade agreements in East Asia – their effects on agricultural trade
ADP/2005/070	Trade liberalisation impacts on small-holder incomes, employment, productivity and public good needs in Indonesia and China
CIM/2003/038	Physiological, genetic and molecular approaches for improving drought tolerance of wheat in China and Australia
PLIA/2005/007	China Linkages Projects
SMCN/2005/059	Modelling water and solute processes and scenarios for optimisation of permanent raised bed systems in China, India, Pakistan and Indonesia

Multilateral

ADP/2005/063	Overcoming barriers to market access for smallholder pig producers in Southeast Asia

China consultations

11–12 October 1999

Priorities for collaborative agricultural research between Australia and China were discussed on 11–12 October 1999 at a consultation between ACIAR and representatives of relevant Chinese Government Ministries, departments and research organisations.

These priorities are not to be considered as officially sanctioned priorities of the Government of China. They are priorities expressed by participants at a consultation at a particular point in time. ACIAR will use them as a framework when assessing proposals for collaborative projects to be supported by ACIAR, subject to further advice and information from China.

Researchers intending to seek ACIAR support for collaborative research projects with Chinese counterparts should, in the first instance, approach one of ACIAR's Research Program Managers.

At the consultation, consensus was achieved on several overarching priority issues. These were the need to manage scarce water resources efficiently; the need to raise farmers' incomes; the need to raise the quality of agricultural products; the opportunities offered by new genetic and information technologies; and the need to deliver benefits to less developed regions in north-western and south-western China.

The following priorities are listed under ACIAR Program areas for convenience.

Agricultural Development Policy and Agricultural Systems Economics and Management

- Agricultural policy studies. market-oriented water pricing policy, price premium for quality grading, grain trade policies; impacts of WTO on relative competitiveness of different sectors, and implications for prices and markets; agricultural and marketing information systems; farm-level [micro-level] impacts of various policies; linkages between agricultural technology development [research], urbanisation and poverty alleviation; and research on how to involve resource users and stakeholders in designing and implementing resource management studies).
- Technology impact assessment. (This includes the impact of developed technologies supported by ACXIAR and other sources; methodology development for impact assessment; potential impact assessment of proposed/required technologies; and farmers' reaction to technologies).
- Rural finance mechanisms (functions of rural banks and credit companies; roles of micro-finance; and roles of farmers' organisations).
- Rural social security and insurance (livestock and crop insurance; disaster relief; and medical care and pensions).

Animal Sciences

- Ruminant production from forage systems in North West and South West China
- Grazing management and protection of the grasslands (socioeconomic and policy issues, pasture /livestock management, rodent control, improved forage production in arable[agricultural] areas).
- Livestock feed production, conservation and utilisation
- Crop by-products, including the use of microorganisms to improve the nutritional value of crop by-products, feed and livestock production simulation, and modelling for efficient management and production.
- Livestock products, processing and marketing (including early stage fine wool processing, and meat quality (beef and mutton grading) and marketing)
- Specific livestock production constraints (including animal health protection and disease prevention, vaccines and disease diagnosis, particularly using biotechnological and molecular techniques, parasite control in sheep and cattle, and information systems for animal production and disease control strategies, processing and marketing).

Crop Sciences

- Design and development of productive and sustainable farming systems for arid regions through a systems approach, assisted by systems simulation and modelling.

- Integrated development of legume crops for semi-arid regions, including variety improvement, development of new uses, improvement of soil fertility, provision of seed supplies, and integration into crop rotations.
- Improvement of quarantine systems, through provision of information and training, and tools for risk analysis and decision making.
- Development of improved germplasm of potato, tomato and brassicas, through conventional and molecular techniques, with resistance to diseases and pests and improved quality.
- Reduction of chemical input in crop production through improved approaches for pests and nutrition management, e.g. development and better use of biological agents, breeding of resistant varieties, etc.

Forestry
- High value products from eucalypt plantations, through improved germplasm and cultivation techniques and optimised processing and utilisation techniques
- Sustainable forest management in sub-tropical areas, through development of sustainability indicators for different management levels, models of productivity and environmental impact of plantations, and breeding strategies for plantation species (e.g. Southern pine).
- Rehabilitation of degraded forest eco-systems for improved community benefits in southwest China, in particular through the use of shelterbelt systems, multiple purpose trees species, and establishment of appropriate infrastructure and monitoring and evaluation systems
- Effective re-forestation technologies for key catchment areas in the Yangtze and Yellow Rivers, the desert area in Xinjiang, and the Taihang mountains, for flood control and improved management of groundwater, with an emphasis on developing tree planting methods for water saving

Land and Water Resources
- Soil fertility improvement and efficient use of chemical fertilisers
- Soil chemical degradation related to nutrient and organic matter depletion, acidity and sodicity
- Farm-scale water-saving technology
- Irrigation system management
- Crop residue management, including alternatives to burning
- Water quality improvement, including impacts of aquaculture
- Other areas of priority included adaptation of precision farming to Chinese conditions; land use policy including economics, pricing systems and tenure; grassland and wetland management; water resource management at the basin scale; soil erosion, salinisation, and desertification; and management of wastes from intensive animal production systems

Postharvest Technology
- Grain quality assessment, including index of deterioration, grading technologies and separate storage, specification of processing quality, and mycotoxins
- Farmer scale technologies for grain storage, including storage structures & technology, pest and moisture management, extension and training
- Postharvest technology for fruit and vegetables, including disease resistance and control, quality maintenance in transport and storage, farmer scale technologies and packaging, and melons in Western China
- Postharvest technology for roots and tubers, including washing systems, bacterial breakdown, and animal feed use.

Two topics for support from other donors for scaling-up of outputs from previous research were also identified. These were Integrated Pest Management in fruit and vegetables to reduce pesticide residues, and pesticide residue and mycotoxin monitoring and regulation. Four priorities for economics and policy research were identified: grain marketing; implications of WTO access; fruit and vegetable marketing and processing; and meat marketing and quality assurance.

ACIAR publications

This list is a selection of titles from ACIAR's range of scientific publications that are relevant to China's agricultural research and development sector. Hard copies are available by emailing comms@aciar.gov.au, or may be requested through ACIAR's China office. Publications may also be downloaded from ACIAR's website, www.aciar.gov.au.

Monographs

32 Working with mycorrhizas in forestry and agriculture

37 Detection and treatment of mineral problems in grazing sheep

46 The distribution and importance of arthropod pests and weeds of agriculture and forestry plantations in southern China

48 Nutrient disorders of sweet potato

54 Survey toolbox of livestock diseases: practical techniques for developing countries

57 Haemorrhagic septicaemia

58 Understanding animal health in southeast Asia

62 Developing forage technologies with smallholder farmers: how to select the best varieties to offer farmers in southeast Asia

74 Nutrient disorders in plantation eucalypts

84 Regional Water and Soil Assessment for Managing Sustainable Agriculture in China and Australia

94 Survey toolbox for aquatic animal diseases

96 Rats, mice and people: rodent biology and management

97 Effects of Globalisation and Economic Development on the Asian Livestock Sector

100 Field methods for rodent studies in Asia and the Indo Pacific

111 High-yielding Anthracnose-resistant *Stylosanthes* for Agricultural Systems

116 China's agricultural and rural development in the early 21st century

Proceedings

38 Forages on red soils in China

44 Bovine Ephemeral Fever and related rhabdovirsus

48 Australian tree species research in China

57 Leucaena: Opportunities and Limitations

62 Mycorrhizas for plantation forestry in Asia

63 Matching Trees and Sites

66 Bluetongue disease in the Asia-Pacific region

73 Mineral problems in sheep in northern China and some other regions in Asia

97 Hypsipyla shoot borers in Meliaceae

105 Postharvest handling of fresh vegetables*

111 Eucalypts in Asia

119 Agriproduct Supply Chain Management in Developing Countries

Technical Reports

25 Economic aspects of raw wool production and marketing in China

32 Production of fine wool in northern China: effect of nutrition and helminth infections

43 Grain market reform in China: global implications

49 Chukrasia: biology, cultivation and utilisation

57 Trials of cold-tolerant eucalypt species in cooler regions of south-central China

60 Building economic decision-making capabilities of Chinese wool textile mills

ACIAR Working Papers

05 Project development assessment: mineral elements limiting sheep production in China (Project 8911)

28 Project development assessment: an economic evaluation of the potential benefits of integrating apomixis into hybrid rice

33 A qualitative assessment of the research capacity and community impacts of three randomly selected ACIAR-sponsored projects

40 Socioeconomic study on farmers' adoption of integrated pest management (IPM) strategies in Brassica vegetable crops in China

41 Developing forage technologies with smallholder farmers: how to monitor and evaluate impacts

55 Forages for the Red Soils Area of China

56 Agricultural research and poverty alleviation: some international perspectives

59 Survey of the mineral status of livestock in the Tibet Autonomous Region of China

ACIAR's Impact Assessment series reports

04 Raw wool production and marketing in China: ACIAR project 8811

08 Australian tree species selection in China

10 Conservation tillage and controlled traffic

13 Breeding and quality analysis of rapeseed

15 Use of management of grain protectants in China and Australia

23 Improved methods for the diagnosis and control of bluetongue in small ruminants in Asia and the epidemiology and control of bovine ephemeral fever in China

26 Impact assessment of ACIAR-funded projects on grain-market reform in China

28 Water and nitrogen management in wheat–maize production on the North China Plain

30 Eucalypt tree improvement in China

32 Shelf-life extension of leafy vegetables—evaluating the impacts

33 Research into conservation tillage for dryland cropping in Australia and China