



**COOPERATIVE RESEARCH CENTRE
FOR SUSTAINABLE RICE PRODUCTION**

ANNUAL REPORT 2000/2001

Part C

PROGRAM 4

PRODUCT AND PROCESS DEVELOPMENT

Program Leader:
Dr Yunus Khatri
Ricegrowers' Co-operative Limited
Leeton

The rice processing sector is in a highly competitive food industry. Quality assurance and measurement is vital at all stages of the production, processing and marketing chain to secure and maintain markets. There are new market opportunities, particularly in the value-added and processed food product sectors.

This Program underpins these important initiatives through targeted and cooperative research.

<p>Case Study</p>	<p><i>Quick cooking rices</i></p> <p>(P Williams and M Bayles)</p> <p>Ricegrowers' Co-operative Ltd staff used Rice CRC research to develop a rice that cooks in a cup with the addition of boiling water and flavour.</p> <p>Developmental research helped overcome difficulties with hydrating the rice in the cup and other problems associated with texture and heat loss.</p> <p>Different rice varieties, including Langi, Kyeema and Doongara, were tried with different settings in the processing plant, while packaging company Carter Holt Harvey developed a sleeve which, in combination with a polypropylene cup, reduced heat loss.</p> <p>These advances delivered a rice product that can be prepared in three minutes with the simple addition of boiling water.</p> <p>This product was demonstrated at the CRC Symposium in February 2001 and has since been commercialised. These quick cooking rices are now available through supermarkets in four flavours - Chicken, Beef, Napoli and Oriental. A rapid cooking Arborio with a six minute cooking time has also been developed from the variety Illabong for use in Risotto Meal Kits and side dishes. These were also commercialised within the reporting period.</p> <p>Other products under development include an eight-minute rice for an industrial customer and a puffed rice made with a single pass through the processing plant rather than the pre-existing technique which involved producing a parboil rice which was then puffed.</p>
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4.1 Grain quality in the pre-milling phase (4101)

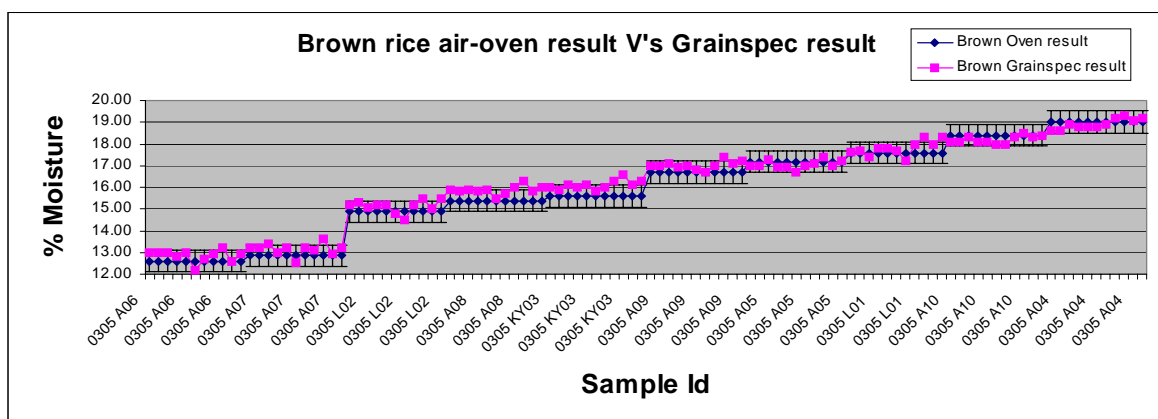
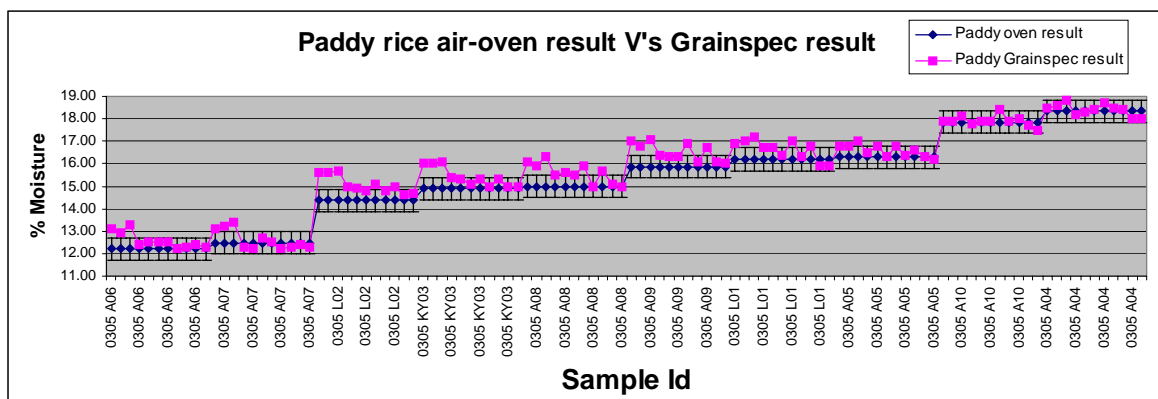
Sub-Program/Project Leader:
Mr Nathan Cutter
Ricegrowers' Co-operative Limited
Leeton

A report on the various sub-projects follows:

- * *2000/2001 Harvest*
- * *Field trial of brown rice moisture measurement at the point of receipt (Mr Nathan Cutter)*

A calibration using near infra-red spectroscopy for the measurement of moisture in brown rice was developed for use at Ricegrowers' Co-operative Limited (RCL) receipt depots. The effective range of the calibration was 11%-28% moisture. Throughout the 2000/2001 harvest, trials were conducted that compared the accuracy of moisture measurements in brown rice compared to the traditional method of moisture measurements in paddy rice. The AACC air-oven moisture test was used as a standard method of moisture measurement to compare the NIRT instrument results.

Results from these trials have demonstrated less measurement variability in grain moisture when measured in brown form. Further research is being conducted to determine the impact that prolonged wet weather, heavy dews and lodging may have on the variability of results between brown and paddy rice moisture.



*** *Trash determination at the point of receipt (Mr Nathan Cutter)***

Trials to find a reliable measurement of trash at the point of receipt have been an ongoing pursuit since 1997. For the 2000/2001 harvest, trash components were calculated indirectly as the inverse of the clean paddy weight in a sample. Frequent quality assurance tests were used to ensure the accuracy of these results.

The Model-S grain cleaner was used in all 19 receipt site testing platforms during the 2001 harvest period. Frequent quality assurance tests were made to ensure that all grain cleaners provided results within a $\pm 0.5\%$ threshold of the standard laboratory instrument. The instrument was used to measure the trash content of growers' paddy as the rice was delivered. The results of the test were provided to the grower, allowing for adjustments to the harvesting equipment to reduce the level of trash brought to the point of receipt in subsequent loads.

*** *Determination of whole grain yield at testing platform (Mr Nathan Cutter)***

Trials have been initiated in order to determine the potential head rice yield of a sample at the point of receipt using the Grainspec NIRT spectroscope. At this stage sample collection is completed and the samples are being milled in order to develop the calibration. The GrainCheck 310 image analyser will be used as the reference instrument to determine the head rice yields of calibration samples.

*** *Drying and storage of rice pre-milling.***

*** *Establishing thresholds for stackburn prevention (Miss Tanya McNamara and Mr Darryl Hill)***

Due to the record rice harvest in 2001 and the limited permanent storage capacity available to RCL, the delivery of newly harvested rice to storage depots was in some cases delayed. A trial was conducted to investigate the impact that prolonged storage of wet paddy rice on farm has on grain quality, in particular the likelihood of stackburn occurring. Stackburn is the heating of wet grain due to microbial respiration and results in yellow to tan, translucent grains that are not gelatinised completely.

Results indicated that the presence of stackburn could be ascertained after only three days of non-aerated storage. (The ambient temperature for the trial period exceeded 25°C and solar radiation above 23 Mj/m^2). The trial also indicated that temperatures within the grain mass needed to exceed 50°C for stackburn to occur.

This trial also highlighted that mould growth may be a significant problem when storing high moisture paddy rice un-aerated and on-farm for prolonged periods of time. Further research is required to accurately determine the length of time and the crucial ambient temperatures and solar radiation that promote stackburn and mould growth.

*** *Aerated bunker (Mr Darryl Hill, Mr Nathan Cutter, Miss Kellie Close, Miss Tanya McNamara)***

Due to a record rice harvest in 2001 and insufficient storage capacity, approximately 100,000 tonnes of rice was stored in bunkers as a temporary storage at the peak of harvest. Bunkers have been associated with lower grain quality, generating increased grain temperature and moisture, leading to significant moisture migration. This may effectively downgrade the quality of the paddy for any future end-use.

In order to reduce problems associated with short-term bunker storage, aerated bunkers have been trialed in other grains industries and were successful in maintaining the grain quality. In consultation with SGRL and Graincorp these designs have been adapted for rice and a 12,000 tonne aerated bunker was designed and constructed at Deniliquin.

Monitoring of the bunker indicated a decrease in the overall temperature of the grain in comparison to a control bunker. However the quality of the rice will not be known until the bunker is open in three to four months. Maintaining a uniform temperature of 14°C throughout the bunker will result in reduced moisture migration and limit the potential for insect infestation.

*** *“Adaptive Discounting” aeration control demonstration trial (Mr James Darby [CSIRO SGRL], Mr Simon Troman [CSIRO SGRL], Miss Tanya McNamara (RCL) and Mr Darryl Hill)***

This trial is a demonstration of the performance of the “Adaptive Discounting” aeration control method (ADC) for drying paddy rice within Ricegrowers’ Co-operative Limited (RCL) facilities. This control method has been developed at the Stored Grain Research Laboratory (SGRL) over the last three years for a broad range of aeration applications; drying, cooling and maintenance. The process has been successfully used for aeration/drying applications in crops such as sorghum and canola, using aerated transportable farm silos.

The specific aims of this trial were to demonstrate the performance of the adaptive discounting aeration control method using existing RCL infrastructure. An additional aim was to measure the capacity of the ADC method to dry paddy rice to a target moisture content within an RCL aeration bin without a significant moisture profile across the depth of the bin.

SGRL with RCL have installed aeration control and data acquisition instrumentation on Gogeldrie shed 4 bin 5 which has controlled the drying process successfully since late March to early June. The target moisture parameters of 14% with an over-drying limit of 13% were selected. The moisture profile across the 6.5 m deep grain bulk has been measured directly via probe sampling and indirectly via electronic relative humidity and temperature sensors.

Although the trial continues, indications are that the capacity of the ADC method to dry paddy rice efficiently shall be met.

4.2 Development of rice milling in-line process control (4201)

Sub-Program Leader:
Mr Scott Brindley
Ricegrowers' Co-operative Limited
Leeton

Objectives

This project aims to develop automated systems to accurately monitor rice processing (milling). Markets are becoming increasingly aware of processing characteristics such as crack development, temperature gradients developed during milling and degree of milling.

Progress

The project has developed a computer-aided control system to manage the vertical milling process to deliver optimum throughput and quality. The system uses actuator control of feed rate with feedback measurement of physical parameters within the mill. The system has been successfully tested at the Leeton mill.

An important component of the project has been the understanding developed of the components that determine quality in the vertical milling process.

A computer interface was also developed for the Grainspec moisture meter. This is now implemented through the receipt and processing system.

Computer control has also been developed for packers/weighers used in the processing lines. This has been implemented in some commercial mills.

Outcomes

- * System developed to control vertical whiteners.
- * Interface for moisture meter developed and implemented.
- * Interface for packer/weighers developed.

4.3 Quality assurance systems and post-harvest pest management

Sub-Program Leader:
Mr Darryl Hill
Ricegrowers' Co-operative Limited
Leeton

The Australian rice industry must continue to meet customers' quality expectations, both domestically and internationally. This Sub-Program focuses on:-

- * Integrated Pest Management, and
- * Food Safety

Physical control of rice – cold disinfestation of rice (4301A)

Project Leader:
Prof Michael Wootton
University of New South Wales
Sydney

It was concluded that the use of sub-zero temperatures for disinfestation of rice was not economically viable. Acceleration of cooling using low temperature fluidised bed approaches was also operationally and economically unfeasible. These results were discussed at a meeting at Ricegrowers' Co-operative Limited in November 2000 attended by representatives from RCL, Dr Laurie Lewin (Rice CRC), Assoc Prof Michael Wootton and Mr Suraj Parkash from The University of NSW. At this meeting it was agreed that the focus of the project would change to the use of heat via fluidised bed technology and hence a new set of objectives have been formulated.

Objectives

- * Extension of work at 12°C to include lesser grain borer, saw tooth grain beetle and flour beetle (*Tribolium sp*).
- * Investigation of time/elevated temperature combinations required to kill insects in rice.
- * Investigation of the impact of lethal conditions of time and temperature on rice quality.
- * Development of mathematical models for prediction of appropriate lethal time/temperature combinations, optimisation of the disinfestation process and obviation of negative effects on rice quality.

In addition, a new set of Milestones has been formulated:-

2001

- * Literature data on heat disinfestation.
- * Preliminary fluidised bed work and process/technique development.
- * Application to paddy, brown and white rice, and quality testing.
- * Extension of 12°C studies to include lesser grain borer, saw tooth grain beetle and flour beetle (*Tribolium sp*).

2002

- * Development of mathematical models.
- * Economic and costing studies.
- * Thesis and final report preparation.

Progress

Storage of medium grain paddy, brown and milled rice at -20°C revealed that rice quality was not adversely affected. However, three weeks was required to reach -20°C in rice in 1 tonne bulker bags and rice in 1 kg retail packs stored on pallets required about half this time. This led to the conclusion that the use of sub-zero temperatures for disinfestation of rice was not economically viable. Acceleration of cooling using low temperature fluidised bed approaches was also operationally and economically unfeasible.

Mortality trials at temperatures between 5°C and 15°C showed an unexpected maximum mortality effect at 12°C on the rice weevil and Indian meal moth. This finding could be of some practical use during storage and drying where such temperatures are induced in the grain due to evaporative cooling from moisture evaporation.

Outcomes

The principal outcome was that cold disinfestation, while effective as a means of insect disinfestation and without negative effects on rice quality, was economically unfeasible.

As a consequence of this, the focus of the project has been changed to heat disinfestation using fluidised bed technology.

The lethal impact of 12°C on the rice weevil and Indian meal moth has commercial potential due to temperatures in this region being achieved during paddy storage and drying due to moisture evaporation.

Sustainable fumigation practices (4303)

**Project Leader:
Mr Darryl Hill
Ricegrowers' Co-operative Limited
Leeton**

**** Treatment of rice products with carbon dioxide applied to shipping containers as dry ice for the purpose of insect control (Mr Darryl Hill)***

The trial was designed to re-investigate the use of shipping containers as fumigation enclosures, primarily for carbon dioxide treatment but also for other gaseous treatments. The current investigation was designed as an investigation into the possibility of using this type of fumigation in a routine large-scale industrial operation to replace methyl bromide fumigation for final disinfestation of rice products.

Objectives

* To explore the gas holding of “normal” containers used by Ricegrowers’ for shipping.

* To investigate the modifications required to dry-ice applications needed to match carbon dioxide treatment requirements to the actual shipping container leakage.

* To evaluate the gas-tightness of shipping containers for fumigation with other gases.

Progress

* *Materials and Methods*

- *Containers and commodity*

Four containers that were part of a normal consignment of containers received at Ricegrowers' Deniliquin Mill were used in the experiment. All four containers had plywood floors, were of various ages, and on visual inspection were in fair to very poor condition (Table 2). Each container was loaded with 9-10 tonnes of white rice placed on ten wooden palettes.

Temperature and relative humidity (rh) measurement

Table 2: Containers used for carbon dioxide treatment

Number	Condition	Age of container	Bag type	Data Logger	Dry ice added
1	Fair	7 month	Bulk	✓	75 kg
2	Fair	9 month	Bulk	✓	75 kg
3	Poor	>10 years	20 kg	✗	110 kg
4	Very poor	12 month	20 kg	✓	95 kg

* *Application of dry ice to rice products*

Dry ice used was in the form of 5 kg blocks. For each container, eight blocks of dry ice (40 kg) were insulated with paper and cardboard to slow the release of CO₂ gas and placed on top of the bags inside the containers. Immediately following addition of dry ice containers were sealed. Containers were treated on 4 April, 2001 and remained sealed until the 14 April, 2001, ten days in total.

* *Carbon dioxide measurements*

CO₂ concentrations were measured with a Gow-Mac Instruments portable GC-TCD (Gas chromatograph with thermal conductivity detector) fitted with a sample pump. Samples were drawn through ¼ inch nylon sample lines that had been passed through the door seals of the containers. Measurements were carried out several times a day over the 10-day exposure period.

* *Results*

Table 3: Results from the 10-day CO₂ container fumigation.

Number	Average Temp (°C)	Ave CO ₂ (%)	CO ₂ (%) <i>after 10 days</i>	Insect Control
1	19.5	35	10	✘
2	19.9	30	14	✘
3	-	26	12	✘
4	19.4	45	10	✘

Conclusions

In-transit CO₂ treatments cannot be seen as a reliable method for end point disinfestation of rice unless an acceptable and reliable process of container selection for gas-tightness can be devised. The logistics are such that this selection has to take place prior to the empty containers being shipped to up-country rice mills.

4.5 New rice-based foods (4501)

Sub-Program Leader:
Mr Phillip Williams
Ricegrowers' Co-operative Limited
Leeton

Objectives

Evaluation of new technologies that will promote the development of new rice-based food products.

Progress

Development work on the quick cooking rice process was concluded during 2001. This resulted in the release of a range of new rice-based products as outlined in the Program 4 case study.

Outcome

New quick cooking rice products have been released through supermarkets in Australia.

Development of new vitamin and mineral fortification technique for rice (4502)

**Project Leader:
Mr Phillip Williams
Ricegrowers' Co-operative Limited
Leeton**

This project aimed to establish a simple means of applying folic acid to rice to produce a new enriched rice containing between 1.54 – 3.08 mg/kg of folic acid. Folic acid (folate) is a vitamin essential to humans and is now added to a range of food products. However folic acid is a bright yellow coloured vitamin and enriched rice using the process currently used to add thiamin and niacin produced bright yellow coloured grains of rice in the finished blend. This was unacceptable to potential purchasers who may have mistaken the enriched rice for 'stack burnt' or damaged rice.

Progress

The project on folate supplementation was completed in 2001. Acceptable levels of folic acid activity were found after at least six months storage. Supplementation has been possible for commercial samples.

An experimental program successfully supplemented polished rice with fluoride. This rice was then used in a pilot study to determine the use of fluoride supplementation in island populations to improve dental hygiene.

Outcomes

Folate enriched rice is now sold commercially in specific markets.

Investigating the physical inter-relationship between rice flour and the protein actomyosin (4503)

**Project Leader:
Mr Phillip Williams
Ricegrowers' Co-operative Limited
Leeton**

Objectives

This project aims to investigate the suitability of Australian rice flours for use as a value-added ingredient in smallgoods and other manufactured products.

Progress

* To collect data on the chemical, physical, gelatinisation and starch gel and water absorption properties of rice flours.

- * To compare rice flours with other cereal flours and modified starches.
- * To investigate the possibility of using rice flours in various applications.
- * To develop methodology for texture analysis of starch.
- * To investigate the use of small “brokens” (broken grain) and other rice varieties for making rice flours.

Progress

Water absorption capacity of rice flours was investigated using flours made from different varieties and resources. Variety, source and particle size all influenced water absorption. Physical modification of the flour and addition of modified starches and vegetable gums also affected water absorption.

Variety, particle size, physical modification and addition of modified starches, all influenced gelatinisation and pasting properties of rice flours. Physical modifications associated with pre-gelatinisation and extrusion had the most dramatic effects.

Particle size and amylose content, within a wide range, were not the key factors influencing firmness and adhesiveness. Varietal differences were important in determining rice gel texture, while amylose content did explain some differences, otherwise varietal effects were more important.

Outcomes

These properties of rice flours have implications for its use as a binder for smallgoods and in bakery products. Variety, particle size, physical modification and additives can all be used to tailor flour for a specific purpose.

Starch-lipid interactions and their role in ageing processes in rice (4504)

**Project Leader:
Prof Kevin Robards
Charles Sturt University
Wagga Wagga**

Objectives

Specific aims are identified as follows:-

- * to investigate the effects of ageing on the pasting behaviour of rice;
- * to elucidate the role of lipids in the ageing process;

- * to be able to control the ageing process in order to produce rice with a desired functionality;
- * to determine the effects of ageing on rice flavour; and
- * to transfer this information to Australian rice growers and processors.

Progress

Analytical data have been collected on three varieties of rice and correlated with ageing at different storage temperatures. At this stage, it is not possible to attribute the ageing process to any chemical or physical change in rice structure.

Arrangements made for use of a differential scanning calorimeter at three establishments failed. This has caused a number of delays in this project. The group (Mr Zhongkai Zhou, Dr Stuart Helliwell and Dr Chris Blanchard) has been successful in obtaining funds for purchase of this equipment, which is due for delivery and installation at CSU in the week commencing July 8, 2001.

MILESTONES

	Milestone	Year 1	Year 2	Year 3	Year 4 - 2000/2001	Yr 5	Yr 6	Yr 7
4.1	Grain quality in the pre-milling phase							
	Appointment of scientific officer	X Consultants used						
	Sampling procedures optimised	X Commenced	X 4					
	Individual grain moisture distribution monitored	X Commenced	X 4	X 4				
	Optimum grain drying strategies developed		X Commenced	X 4	X 4	X		
	Training programs developed		X Deferred	X 4	X 4			
	Training programs implemented			X 4	X 4	X	X	X
4.2	Development of rice handling in-line process control							
	Software development	X Commenced	X 4					
	Closed loop control developed for degree of milling/whitening		X Commenced	X 4				
	Moisture meter interface developed	X 4	X 4					
	Packer weigher interface developed	X 4	X 4					
	Process weigher interface developed	X 4	X 4					
	Closed loop system for broken grain content developed			X 4	X 4	X		
	Closed loop system to maximise hulling efficiency developed					X	X	X
	System implementation					X	X	X
4.3	Quality assurance systems and post-harvest pest management							
	IPM strategies evaluated - Ethyl formate - CO ₂ fumigation - Cool temperature treatment - Phosphine fumigation - Carbonyl sulphide - Designing out pests	X X X X X	X Commenced X Commenced X Deferred	X Continuing X Implementation X 4 X 4	X 4 X Discontinued	X		
	HACCP systems - rice-based foods plant - mills and stock food plants - rice receival sheds and on-farm	X Commenced 4 (flour mill)	X 4 X Commenced	X RCL	X RCL	X	X	X
4.4	Rice hull use							
	Potential for energy conversion determined	X 4 No potential	X n/a	X n/a				
	Potential for hull-based alternatives determined	Commenced	X Continuing	X Continuing	X RCL			
	Other uses for hulls investigated				X RCL	X	X	X
4.5	New rice-based foods							
	Quick cook rices developed	X Commenced	X 4	X 4	X 4	X		
	Feasibility for pouch-packed cooked & frozen rice	X Commenced	X 4 Feasibility study completed however RCL has deferred decision on commercial viability					
	Frozen rice products developed & test marketed			X Not feasible				

Milestone	Year 1	Year 2	Year 3	Year 4 - 2000/2001	Yr 5	Yr 6	Yr 7
Development of pouch packed products		X Commenced	X 4	X 4	X		
Evaluation of waxy rice flour	X Commenced	X No application	X Other flours investigated	X 4			
Potential to produce and market rice noodles evaluated	Evaluated and discontinued	Re-evaluated	4				
Other rice-based products evaluated			4	X 4	X	X	X

X = To be completed (in some cases this exercise is spread over several years).

4= Achieved (if not achieved, status provided.)

EDUCATION AND TRAINING

Education is a cornerstone of the CRC for Sustainable Rice Production. It is administered as a separate program (Program 5) but it has links to all research programs through its role in administration of postgraduate students and in transfer technology.

The research aspects of the education and training program are reported in this section along with the general aspects of education and training in the Rice CRC.

PROGRAM 5

EDUCATION, SKILLS DEVELOPMENT AND TECHNOLOGY TRANSFER

Program Leader:
Dr Philip Eberbach
Charles Sturt University
Wagga Wagga

While the aim of research is ultimately the pursuit of new knowledge and its potential for application, the success of research is often interpreted as the development of new information and its adoption into practice by its clients. The CRC for Sustainable Rice Production has as its core Program 5, which has as its business, the transfer of knowledge generated by the other Programs into practice. It does this by:-

- * providing information of new research to the community;
- * providing vocational training to people involved in grain production and processing;
- * facilitating tertiary training at the undergraduate level;
- * financing research training at the honours and postgraduate level;
- * investigating the socio-economic fabric of the community associated with rice industry;
and
- * conducting research into information adoption to improve the realisation of knowledge into practice.

Along with conducting its major avenues of business, over the summer of 2000/2001, Program 5 conducted a summer students program. This program was aimed at 2-3 year undergraduate students and enabled the successful scholars to gain some experience of the rice industry. The program was successful and plans are underway to run it again during the summer of 2001/2002.

5.1 Sustainable rice production through farmer education and community awareness (5101)

**Sub-Program/Project Leader:
Mr Warwick Clampett
NSW Agriculture
Griffith**

The aim of this Sub-Program is to raise awareness of Rice CRC objectives and progress, particularly with the rice farming community. This has been facilitated through the network of NSW Agriculture agronomists and by newsletter mail-out to growers.

Progress

Rice CRC research was discussed at the series of field days in March 2001 and the pre-season meetings in August/September 2000. Subjects discussed included cold tolerance research (Project 2201), rice quality in the pre-milling phase (Project 4101) and studies in disease susceptibility (Project 2402).

There were also opportunities to discuss Rice CRC projects at the many farmer discussion groups that are a feature of the rice extension system. These groups are facilitated by district agronomists of NSW Agriculture and are a very successful component of the rice extension system.

The extension system of NSW Agriculture continues to maintain good connections with the rice farming community. Research results from CRC projects, as they are developed, will be continually extended through this system. This outlet is supported by the work of many agribusiness representatives. Many of these also have some links to Rice CRC programs.

5.2 Extension and information technology methods

**Sub-Program Leader:
Mr A (Tony) Dunn
Charles Sturt University
Wagga Wagga**

Scoping out a socio-economic research agenda for the Rice CRC (5203)

**Project Leader:
Prof John Spriggs
Charles Sturt University
Wagga Wagga**

Objective

The aim of this project was to define a socio-economic research agenda for the Rice CRC.

The methodology was to develop a research framework and then use this framework as a basis for constructing the research agenda.

Progress

The research framework was developed in four stages: (1) initial tentative framework based on a priory reasoning; (2) extensive literature search; (3) semi-structured interviews with key informants; (4) modified framework based on the findings in (2) and (3). A schematic of the modified research framework appears below as Figure 9.

According to this schematic, the solid arrows indicate the main direction of effects while the broken arrows indicate secondary (feedback) effects. Beginning with Box 1, the drivers for change may arise from outside the Irrigated Rice System (eg, environmentalists, globalisation) or from inside (eg, innovative farmers). They lead to changes in technology and institutional arrangements (formal and informal rules governing behaviour) as indicated in Box 2. These changes in turn have socio-economic effects on the Irrigated Rice System (Box 3) that, in turn, lead to flow-on socio-economic effects outside the Irrigated Rice System (Box 4). The socio-economic effects summarised in Boxes 3 and 4 may in turn engender their own response which can affect the drivers for change (Box 1).

For example, the introduction of water trading (a new institutional arrangement) will have socio-economic effects both inside and outside the Irrigated Rice System and these effects may encourage the local community to respond by resisting the change or by creating new institutional arrangements to enable the community to better adapt to the introduction of water trading.

The framework in Figure 6 was used as a basis for constructing a socio-economic research agenda. The agenda contained four components, which corresponded to the four Boxes of Figure 9. They are summarised as follows:-

1. Drivers for change – the main objective of research here should be to determine which drivers are based on objective reality and which are not (e.g. from poorly informed environmentalism). Where the drivers are based on objective reality, the research will support change, but where they are based on misperceptions, the research will not.
2. Changes in technology and the institutional arrangements – the main objective of research here should be to ensure that whatever changes are proposed will contribute to social well-being.
3. Socio-economic effects on the Irrigated Rice System – the main objectives of research here should be to:-
 - (a) measure the effects of changes on the Irrigated Rice System; and
 - (b) assist participants to respond effectively to the changes that are occurring.
4. Flow-on socio-economic effects outside the Irrigated Rice System – the main objectives of research here should be to:-
 - (a) measure the effects of changes outside the Irrigated Rice System; and
 - (b) assist stakeholders to respond effectively to these changes.

Within each of the four research categories, it is suggested that some specific research methodologies are appropriate.

The strongest message to emerge from the research was the importance of the ‘triple bottom line’ (ie, social, economic and environmental effects of water reform). Many challenges present as wicked problems not solvable by simplistic formulas for change based on scientific evidence alone. Trans-disciplinary research teams of social, economic, environmental and biophysical researchers are needed to provide the data required to enable communities most affected by changes in technology and institutional arrangements to respond appropriately. Social change through participatory action research and developing learning communities appear to be the key. This underlies the proposed socio-economic research agenda.

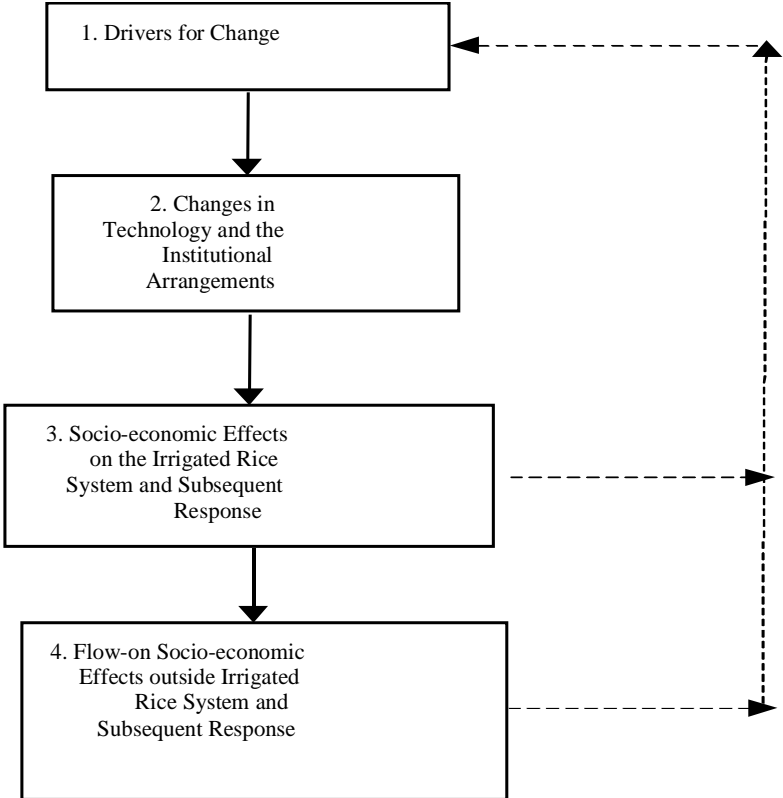


Figure 6: Schematic of the Modified Framework

The research and development of agricultural extension: cultivating sustainable rice in Australia (5204)

**Project Leader:
Mr A (Tony) Dunn
Charles Sturt University
Wagga Wagga**

Objectives

This project will adopt an approach from the sociology of rural development, and while reflecting upon this theoretical foundation through the practice of research, aims to generate knowledge of:-

- * general relevance to the science and practice of agricultural extension;
- * specific relevance to the issue of sustainability in the landscape of Australian rice.

Progress

This project commenced in March 2001 with the appointment of a PhD student, Mr Andy Brown.

* *Training*

Attendance of a training program entitled “Research in practice: social research methods for extension practitioners” conducted by The University of Melbourne, informed the process of developing a research methodology.

* *Presentation*

The student successfully presented a project outline to the Charles Sturt University postgraduate seminar program.

* *Evaluation*

Contributions were requested from, and provided to, the consultancy group hired to conduct an evaluation of rice industry extension services.

* *Farmer contacts*

In addition to networking with Rice CRC program staff and NSW Agriculture agronomists, a number of contacts have been established with rice farmers in advance of field work.

* *Literature review and research proposal*

The required literature review and final research proposal is expected to be completed on time.

5.3 Sustainable rice production through skills development

Sub-Program Leader:
Mr Geoff Creek
Murrumbidgee College of Agriculture
Yanco

This Sub-Program operates at two levels. The first aims at developing the skills base for industry participants at all levels. The second is to increase awareness of the rice industry and particularly rice research, through schools and the community.

Sustainable rice production through skills development (5301)

**Project Leader:
Mr Geoff Creek
Murrumbidgee College of Agriculture
Yanco**

Objectives

To create and provide accredited skills training for the production and processing sectors of the rice industry.

Progress

Original skill development needs that were identified by the steering committee in 1999 and 2000 have been addressed in the development of five short courses. These short courses have been aligned with relevant industry competencies and successfully piloted at a number of locations.

Other areas of education and training identified by the Steering Committee during 2000/2001 and currently under development include:-

- * Development of formal training and skills elements as part of rice grower groups.
- * Rice processing, (value added products, by-product development).
- * Improve public awareness of the Australian rice industry.
- * Business management – dealing with the increased paper work.
- * Machinery set-up.

The steering committee also increased its membership and improved communication between industry groups and CRC Sub-Programs. The committee has also been successful in enhancing the critical analysis of skill development needs of the rice industry.

Further links between Sub-Programs have developed and strengthened over the past season. In particular links between Sub-Programs 5.2 and 5.4 have provided the beginnings of a coordinated rice curriculum providing career development pathways at all levels of the rice industry.

Outcomes

Courses developed as at July 2001, include:-

- * Introduction to Rice Farming in Australia - Pilot 1, September 1999;
- * Growing Australian Rice (grower course) – Pilot 1, June 2001;

- * Growing Australian Rice (agronomist/agribusiness course) - Pilot, July 2001;
- * Operate a Rice Colour Sorting Process – Certificate in Food Processing (Rice Processing). Pilots at Leeton and Deniliquin Mills;
- * QA on the Rice Farm - Approved Supplier Course for Rice Growing - Ready for Pilot.

The module “Operate a Colour Sorting Process” has established a template for the delivery and assessment of modules in the Food Processing Certificate being developed. This certificate is intended to be the current ‘millers’ course.

Overseas interest has also been expressed in the Growing Australian Rice short course.

Rice CRC education officer (5302)

**Project Leader:
Mr Geoff Creek
Murrumbidgee College of Agriculture
Yanco**

Objectives

The project aims to deliver information to school students, the general community and international visitors on the rice industry, rice research and Rice CRC Programs. Specific objectives are to:-

- * develop specific display materials and presentations;
- * arrange visits;
- * coordinate or participate in presentations for schools, community groups and international visitors.

Progress

The resources and exhibits for use with visiting groups are continuing to be upgraded so that they can be used for tours, field days and static displays and also by other staff as teaching aids.

A change in the Year 11/12 Geography syllabus has resulted in a greater subject choice and rice is no longer as popular an option for study by many schools, resulting in fewer school group visits. In contrast, the number of requests from individual students for printed rice information has increased.

A decline in the number of visitors to the Yanco Agricultural Institute in the past 12 months has led to the decision to postpone plans to develop a permanent visitor's centre on site.

A combined approach to raising community awareness of rice field biodiversity and water quality will be made with the Department of Land and Water Conservation's project, "Streamwatch". This is an opportunity to educate community and school groups within the rice growing area as to what is actually happening on a rice farm.

Outcomes

To encourage interest from school students and to make up-to-date information available, a number of rice fact sheets will be produced to supplement the information already available to students. These fact sheets will be able to be easily updated and distributed as necessary. Further work on display props will continue - including posters, resin casts and dried plant specimens.

5.4 Professional development for sustainable rice production (5401)

Sub-Program/Project Leader:
Dr Philip Eberbach
Charles Sturt University
Wagga Wagga

The Sub-Program's principal function is the provision of training at the tertiary level. The Program sponsors two education officers at Charles Sturt University in the areas of rice agronomy and cereal technology. The specific objectives of the sub-program are to:-

- * provide undergraduate and postgraduate course material and the experiences necessary for students intending to work in the rice production and processing industries;
- * provide postgraduate study opportunities within each of the Rice CRC research programs;
and
- * provide training and education opportunities at the postgraduate level to enable the extension and research personnel already employed with the rice industry to further develop their qualifications and experience.

Progress

The education officers are both actively involved in undergraduate teaching programs with particular emphasis on education of relevance to the rice industry. Currently the University has proposed a new degree in Irrigation and Dr Siva Sivapalan has been significantly involved in its creation and in the provision of specialist subjects in relation to the agronomy of summer crops. Aside from his involvement in undergraduate teaching, Dr Blanchard has been actively involved in the development of a research team through the Farrer Centre with interests in food technology. This group has active research interests in rice products and vegetable oils, and the dynamism of the group suggests that its interest in rice will remain well after the cessation of the CRC for Sustainable Rice Production.

Over the past year, the education officers have been meeting at regular intervals with their designated research Programs. The purpose of this initiative is for the officers to be regularly updated regarding the research output from each Program and to enhance the transfer of this research output from each of the Programs into material for the undergraduate programs. To date this initiative appears to have been successful and we are keen to monitor its performance into the future.

Visiting scientist program, conference attendance and scientific visits (5403)

**Project Leader:
Dr Laurie Lewin
CRC for Sustainable Rice Production
Yanco**

Objectives

To provide opportunities for scientific exchange with international scientists through facilitating exchange and conference attendance.

Progress

Some international exchange opportunities are provided through individual projects but this project is designed to facilitate additional exchange. This is seen as important in ensuring that CRC participants are fully informed of the latest advances in rice science and education. Dr Melissa Fitzgerald visited Texas to study applications of microsatellite markers for rice quality evaluation. She spent time with Dr Park at Texas A & M University and Dr Bergman at the United States Department of Agriculture Quality Laboratory in Beaumont.

Ms Andrea Wilson was funded to attend the British Ecological Society Winter Meeting for discussion of her work on invertebrate biodiversity. In particular she attended a workshop on stable isotope analysis. She also visited Dr Heong at the International Rice Research Institute who has important research on fauna communities in rice fields.

Others to have received support were:-

Dr Laurence Cantrill and Mr M.E.A. Mamun for attendance at the COMBIO 2000 Conference of the Australian Society of Plant Physiologists, Wellington, New Zealand; Ms Sandra Oliver for attendance at the Cereal Health and Life Conference, Gold Coast, NSW; and Dr Terry Haig who attended a Mass Spectrometry Conference on the Gold Coast, NSW.

CRC training program (5404)

**Project Leader:
Dr Laurie Lewin
Rice CRC/NSW Agriculture
Yanco**

The Rice CRC acknowledges the value in provision of training opportunities that add to the vocational and scientific training offered through the narrow area of participation in the CRC.

CRC participants are provided with opportunities for exposure to other areas of the rice industry through events such as the Chairman's Tour and the field trip component of the Annual Symposium. The CRC also hosts visits from students enrolled with partner universities to broaden their knowledge of the rice industry and the research environment.

Leadership training has remained an important area for the CRC and it was successful in nominating two students to attend the CRC Leadership and Career Development Course to be held in Melbourne in August 2001.

The Rice CRC is also offering a communication presentations skills course and a media skills course in October 2001 to its participants who are likely to be dealing with the media or making presentations regarding their CRC projects.

5.5 Studentships

**Sub-Program Leader:
Dr Philip Eberbach
Charles Sturt University
Wagga Wagga**

Postgraduate student scholarships and work experience (5501)

**Project Leader:
Dr Philip Eberbach
Charles Sturt University
Wagga Wagga**

The Rice CRC currently supports 24 postgraduate students. This number has increased by seven since last year, as in late 2000 the program underwent a postgraduate recruitment drive and located a further four postgraduates. Two of the recruited postgraduates were offered full scholarship packages while two others were offered "top up" packages. The other three were accepted as postgraduates on specific projects.

Given the stage of this CRC, it is unlikely that any further broad scale recruitment of postgraduates will occur but some postgraduates may be taken on, attached to specific projects.

At this stage no postgraduates have completed, however two are close to completion. Within 12 months it is likely that approximately six postgraduates should have submitted their thesis for examination.

Summer student program (5503)

Project Leader:
Dr Philip Eberbach
Charles Sturt University
Wagga Wagga

During the 2000/2001 growing season, we trialed the summer studentship program. Four scholars were appointed:-

Benjamin Schultz: *Enzymatic bioremediation of pesticide contamination in the environment.* (Supervisor - Dr Robyn Russell, CSIRO Entomology)

Edward Cay: *Effect of polymers on reducing the dispersive properties of sodic soils when flood irrigated.* (Supervisor - Dr Siva Sivapalan, Charles Sturt University)

Fiona McCartney: *Assessing rice crop nitrogen requirements.* (Supervisor - Brian Dunn, NSW Agriculture)

Matthew Tubb: *Quantifying rice crop water use requirements.* (Supervisor - John Thompson, NSW Agriculture)

The program was successful. Students learned first hand of the rice industry and got good exposure and experience of the research environment. At the completion of their projects, students presented seminars to their host institutions and at the stage of writing of this report, one project has to date been written up and submitted for presentation as an oral paper at the 2001 Irrigation Association of Australia Conference. The summer studentship program will be run again over the 2001/2002 irrigation season.

Honours student program (5505)

Project Leader:
Dr Philip Eberbach
Charles Sturt University
Wagga Wagga

In previous years Program 5 had sponsored the occasional honours scholar, however during 2000 it was decided to trial an honours scholarship program with the funding of three honours scholarship packages over the 2001 academic year. Whilst a number of applications were received, only one honours scholar was appointed. The Rice CRC intends to run the honours program again in the 2002 academic year and to date several high calibre students have expressed an interest in the program.

5.6 External communications (5601)

Sub-Program/Project Leader:
Mr Michael Cook
Rice CRC
Yanco

Objectives

The project aims to promote awareness and understanding of the Centre and its achievements among rice and irrigation industry participants, the broader community and government at all levels.

Specific objectives are to:-

- * acquaint the community with Rice CRC philosophies and emphasise the vital nature of its research activities, extension services and education programs;
- * market the uptake of Rice CRC research outcomes by industry;
- * support and enhance the Rice CRC's linkages; and
- * develop and maintain a strong, productive relationship with the print and electronic media.

Progress

The 12 months to July 2001 was a period of consolidation. The foundation projects which were undergoing development during the Sub-Program's first year of operation (1999/2000) were implemented during this period.

- * The Centre's website became fully operational on September 1, 2000.
- * A web-based publishing system was implemented in 2000/2001. This provides a cost-efficient standard platform for the production and publication of the Centre's research reports.
- * The Centre strengthened relations with regional media and generally increased the output of material communicating Centre activities.

Outcomes

- * Usage monitoring revealed more than 3,500 people accessed information from the Rice CRC website in its first nine months of operation.

- * It is estimated (using available media circulation and audience figures) that an average of 320,000 people may have been reached with each media release or interview generated by the Centre during 2000/2001.
- * Communication of the Centre's work on cold tolerance and water use efficiency in May 2001 was carried by news outlets with a potential audience in excess of 1.6 million people.
- * Representatives of eight media outlets attended the Rice CRC's 2001 Symposium.
- * The Centre was a major contributor to an educational CD-ROM in the Murray-Darling Basin Commission/NSW Board of Studies Waterlines series, "Exploring the Rice Industry in the Australian Riverina" and assisted in the production of the award-winning educational book "The Story of Rice", published by the Kondinin Group.
- * Centre participants delivered background briefings on Rice CRC activities and the CRC Program to business and government delegations from China, Malaysia, Cambodia and North and South Korea.

Current students (continuing or completing studentship in 2000/2001)

<i>Name</i>	<i>Commencement Date</i>	<i>University</i>	<i>Type of enrolment</i>	<i>Supervisor and Associate Supervisors</i>	<i>Funding source(s) CRC/Uni etc</i>	<i>Thesis Title (Related CRC Sub-Program)</i>
Ms Louisa Best	2-1-01	Charles Sturt Univ	PhD	Dr Shahbaz Khan (CSIRO L&W)	CRC	Risk based spatial modelling to identify regional soil salinity trends in irrigation areas. (1.4)
Mr Andrew Brown	1-3-01	Charles Sturt Univ	PhD	Mr Tony Dunn (CSU) Dr Ian Gray (CSU) Dr Warren Muirhead (CSU)	CRC	Understanding the channels of communication: improving the adoption of research findings by farmers. (5.2)
Ms Ayesha Burdett	1-8-99	Univ of Melbourne	Honours	Dr Mark Stevens (NSW Ag) Prof David MacMillan (MU)	CRC	Acute and chronic toxicity of three rice field herbicides to non-target aquatic invertebrate fauna (2.4) (completed 31-12-2000)
Mr Jeffrey Castro	1-3-01	Univ of Sydney	PhD	Prof Robert (Bob) Gilbert (SU) Dr Melissa Fitzgerald (NSWAg) Dr Matthew Morell (CSIRO PI)	CRC (Part)	Customising molecular architecture of starch for rice quality - biochemistry aspects. (3.4)
Mr Herbert Chiou	19-3-01	Univ of Sydney	PhD	Prof Robert (Bob) Gilbert (SU) Dr Melissa Fitzgerald (NSWAg)	CRC (Part)	Customising molecular architecture of rice polymers for rice cooking - characterisation aspects. (3.4)
Ms Jennifer Dang	1-7-99	Univ of Sydney	PhD	Dr Les Copeland (SU) Mr Phillip Williams (RCL)	CRC	New rice-based food products (4.5)
Mr Greg Doran	29-1-01	Charles Sturt Univ	PhD	Dr Kaye Spark (CSIRO L&W) Dr Phil Eberbach (CSU)	CRC	The determination of the role of sediments in the persistence of pesticides in rice floodwaters and drains. (1.3)
Mr Robert Duncan	17-8-98	Univ of Sydney	Masters	Prof Graeme Batten (CSU) Dr Lindsay Campbell (SU)	CRC	An investigation of factors influencing the deposition of iron and zinc in rice grain (2.3)
Mr Andrew Eamens	19-4-99	Charles Sturt Univ	PhD	Dr Chris Blanchard (CSU) Dr Narayana Upadhyaya (CSIRO PI) CSU/NSW Ag	CRC & CSU	Investigation of the molecular mechanisms of starch quality (3.4)
Mr Mohammad Ezaz El Mamun	4-5-98	Univ of Sydney	PhD	Dr Bruce Sutton (SU) (linked to cold program)	CRC	The role of callose in cold damage of rice pollen (3.2)
Mr Tim Farrell	1-8-98	Univ of Qld	PhD ¹	Assoc Prof Shu Fukai (QU) Mr Rob Williams (NSWAg)	Self - funded	Genotypic variation and expression of low temperature tolerance in rice (2.2)
Mr Manoj Gupta	3-7-2000	Univ of Sydney	PhD	Dr Norm Darvey (SU)	CRC	Microspore culture of japonica rice (3.3) (Withdrew 11-01-2001)
Mr Thusitha Gunawardena	1-4-99	Univ of Qld	PhD	Dr Shu Fukai (QU) Dr Pax Blamey (QU) (linked to cold program)	ACIAR & CRC	Effect of low temperature during the reproductive stage in rice (2.2)
Ms Rama Heidari	1-6-98	Charles Sturt Univ	PhD	Dr John Oakeshott (CSIRO) Dr Gavin Ash (CSU) Dr Robyn Russell (CSIRO)	CRC	Bioremediation of pesticide residues in drainage waters (1.3)

¹ Mr Tim Farrell has been shown in previous Annual Reports as undertaking his Masters degree, however he upgraded this to a PhD on 19 November, 1999.

<i>Name</i>	<i>Commencement Date</i>	<i>University</i>	<i>Type of enrolment</i>	<i>Supervisor and Associate Supervisors</i>	<i>Funding source(s) CRC/Uni etc</i>	<i>Thesis Title (Related CRC Sub-Program)</i>
Ms Anita Hodson	July 2000	Univ of Technology Sydney	Masters	Dr Noel Merrick (UTS)	CRC	Groundwater flow and solute transport simulation model at Stotts farm, MIA. (1.4) (completed 1-3-2001)
Mr Nijat Imin	1-7-2000	Aust. National Univ	PhD	Prof Barry Rolfe (ANU) Dr Jeremy Weinman (ANU)	RIRDC/ CRC	Investigation of molecular mechanisms causing cold-induced sterility in rice (3.2)
Mr Suraj Parkash Kapila	26-7-99	Univ of NSW	PhD	Assoc Prof Michael Wootton (UNSW)	CRC	Cold disinfestation of rice (4.3)
Mr Tursun Kerim	4-5-2000	Aust. National Univ	PhD	Dr Jeremy Weinman (ANU) Prof Barry Rolfe (ANU)	CRC	Characterisation of the developmental pathway of pollen maturation in rice anthers (3.2)
Mr Jeffrey McCormick	17-01-01	Univ of Sydney	Honours	Dr Lindsay Campbell (US) Prof Graeme Batten (CSU)	CRC	Optimising a nutrient solution for rice (2.3/5.5)
Ms Megan McLachlan	Nov 1999	Univ of Technology Sydney	Masters	Dr Noel Merrick (UTS)	CRC	Data collection report for the modelling of groundwater dynamics & salinity at Stotts farm, MIA (1.4) (Completed 1-3-2001)
Ms Sandra Oliver	14-2-2000	Charles Sturt Univ	Honours	Dr Chris Blanchard (CSU) Mr Paul Roffey (CSU)	CRC	Investigation of genetic diversity in rice cultivars (3.4/5.5) (Completed 31-12-2000)
Ms Sandra Oliver	20-2-01	Charles Sturt Univ	PhD	Dr Rudy Dolferus (CSIRO PI) Dr Liz Dennis (CSIRO PI)	CRC & CSU	Identification & characterisation of genes affected by cold treatment of rice anthers (3.2)
Mr Xu Peng	1-8-98	Univ of NSW	PhD	Dr Yaping Shao (UNSW) Mr Charles Demetriou (NSW DLWC)	CRC	A new integrated system for modelling land salinisation – with emphasis on the prediction of salinity in irrigation areas (1.4)
Mr Wayne Pitt	9-2-98	Charles Sturt Univ	PhD	Dr Gavin Ash (CSU) Dr Ric Cother (NSWAg)	CRC	Studies on the host range and aggressiveness of <i>Rhynchosporium alismatis</i> in rice fields (2.4)
Ms Liesl Schiller	1-1-2000	Univ of Sydney	Masters	Dr Mark Stevens (NSW Ag) Assoc Prof Richard Russell (SU)	CRC	The phenology and abundance of mosquitoes in NSW rice fields and associated habitats (2.4)
Ms Alexa Seal	1-12-98	Charles Sturt Univ	PhD	Prof Jim Pratley (CSU) Dr Terry Haig (CSU) Dr Laurie Lewin (CRC)	CRC	Allelopathy in rice to control weeds in NSW (3.2)
Ms Sarah Spackman	2-2-98	Charles Sturt Univ	PhD	Dr David Lamb (CSU) Mr Jon Medway (CSU)	CRC	Using airborne multispectral imaging to manage within-paddock variability in rice production (2.1)
Ms Skye Wassens	5-3-01	Charles Sturt Univ	PhD	Prof Alistar Robertson (CSU)	CSU & CRC	Conservation biology of the endangered Southern Bell Frog. (2.4)
Ms Kahli Weir	1-3-01	Charles Sturt Univ	PhD	Dr John Oakeshott (CSIRO) Dr Robyn Russell (CSIRO)	CRC	Enzymatic bioremediation for pesticide residues in irrigation tailing water. (1.3)
Ms Andrea Wilson	30-3-98	Charles Sturt Univ	PhD	Dr Mark Stevens (NSWAg) Dr Robyn Watts (CSU)	CRC & CSU	The effect of different management regimes on aquatic consumers and food sources in rice agroecosystems (2.4)
Ms Briony Wiltshire	Jan 2000	Univ of Sydney	Honours	Dr Lindsay Campbell (SU) Prof Graeme Batten (CSU)	CRC	Low phytic acid rice (2.3) (Completed December 2000)

<i>Name</i>	<i>Commence- ment Date</i>	<i>University</i>	<i>Type of enrolment</i>	<i>Supervisor and Associate Supervisors</i>	<i>Funding source(s) CRC/Uni etc</i>	<i>Thesis Title (Related CRC Sub-Program)</i>
Mr Zhong Kai Zhou	4-1-2000	Charles Sturt Univ	PhD	Prof Kevin Robards (CSU) Dr Stuart Helliwell (CSU)	CRC	Starch-lipid interactions and their role in ageing processes in rice (4.5)

Ms Megan McLachlan and Ms Anita Hodson graduated with MSc degrees from the University of Technology Sydney in May 2001. Both received High Distinctions. Ms Sandra Oliver received a University Medal from Charles Sturt University on completion of her Honours studentship.

Previous students

<i>Name</i>	<i>Commencement and Finish Dates</i>	<i>University</i>	<i>Type of enrolment</i>	<i>Supervisor and Associate Supervisors</i>	<i>Funding source(s) CRC/Uni etc</i>	<i>Thesis Title (Related CRC Sub-Program)</i>	<i>Award</i>	<i>Graduate Employment</i>
Ms Zara Evans	1-3-99 to 1-12-99	Univ of Sydney	Honours	Dr Lindsay Campbell (SU) Dr Graeme Batten (NSWAg)	SU	Amino acids, mineral elements and the quality of rice (2.3)	B.ScAgr Hons II 1	Dalgety Wesfarmers
Ms Sussan Fernandes	1-7-98 Withdrew 7-6-2000	Univ of Sydney	PhD	Dr Liz Dennis (CSIRO) Dr Lindsay Campbell (SU)	CRC	Molecular basis of cold-induced male sterility in rice (3.2)		Withdrew to pursue non-scientific research career path.
Mr Stefan Hansen	1-1-99 to 1-12-99	Charles Sturt Univ	Honours	Dr Stuart Helliwell (CSU) Dr Mark Stevens (NSWAg)	CRC	Examination of the rice snail, <i>Isidorella newcombi</i> , as a biomonitor for pesticide contamination of aquatic systems (2.4)	B.Appl Sc (Chem) Hon I	
Ms Karen Herbert	Feb 1999 Withdrew 10-3-2000	Univ of Sydney	PhD	Dr Bruce Sutton (SU) (linked to cold program)	CRC	Pathways of assimilate transport within the rice anther (2.2)		
Mr Vincent Lanoiselet	1-4-98 to 31-3-99	Charles Sturt Univ	Honours	Dr Ric Cother (NSWAg)	CRC	The production, germinability and infectivity of survival structures of <i>Rhynchosporium alismatis</i> , a candidate mycoherbicide for the control of <i>Alisma lanceolatum</i> and <i>Damasonium minus</i> in rice (2.4)	Ingenieur Degree (French)	NSW Ag/ CSU/CRC (Project 2407)
Mr Golam Moustafa	1-1-2000 Withdrew March 2000	Univ of Sydney	PhD	Dr Norman Darvey (SU)	CRC	-		
Ms Elaine Murray	1-10-98 Withdrew from Masters January 2000	Charles Sturt Univ	PhD ²	Mr Tony Dunn (CSU) Mr Ken Eustace (CSU) Coleambally Irrigation Cooperative Limited	CRC	Enhancing information exchange in farming communities (5.2)		Coleambally Irrigation Cooperative Limited
Mr David Smith	3-4-98 Withdrew June 1999	Charles Sturt Univ	Masters	Dr Liz Humphreys (CSIRO) Doug Godwin (CSIRO) Dr Philip Eberbach (CSU)	CRC	Using models to quantify the benefits of crops after rice (1.2)	-	CSIRO Land & Water

² Converted from PhD to Masters 5/99 following Ms Murray taking up position with Coleambally Irrigation Cooperative Limited (Land & Water Management Plan). Ms Murray subsequently withdrew from her Masters in January 2000.

<i>Name</i>	<i>Commencement and Finish Dates</i>	<i>University</i>	<i>Type of enrolment</i>	<i>Supervisor and Associate Supervisors</i>	<i>Funding source(s) CRC/Uni etc</i>	<i>Thesis Title (Related CRC Sub-Program)</i>	<i>Award</i>	<i>Graduate Employment</i>
Ms Stephanie Vaughan	22-2-99 Withdrew 30-12-99	Charles Sturt Univ	PhD	Dr Melissa Fitzgerald (NSWAg) Dr Chris Blanchard (CSU)	CRC	Investigation of sun cracking in rice (3.4)		

MILESTONES

	Milestone	Year 1	Year 2	Year 3	Year 4 - 2000/2001	Yr 5	Yr 6	Yr 7
5.1	Farmer education and community awareness							
	Extension officer awareness	X Partially completed	X 4	X 4	X 4	X	X	X
	Extension program development		X 4	X 4	X 4	X	X	X
5.2	Extension & information technology methods							
	Appointment of research student	X Delayed	4 Completed					
	Baseline extension study	X Commenced	X 4 Completed					
	Subsequent studies			X In development	X 4		X	X
	Evaluation of novel extension technology	X Commenced	X In progress	X In progress	X 4			
	Appointment of post doctorate fellow				X converted to postgraduate			
	Comparison with existing techniques			X Deferred	X 4	X	X	X
5.3	Skills development							
	Industry education officer appointed	X 4						
	Training needs analysis completed	X Commenced	X 4					
	Training courses developed for: - production - industry - leadership - facilitation		X 4 X 4 X Commenced	X 4 X 4 X Achieved in other Programs X 4	X 4 X 4 X 4	X X X		
	Training courses run		X Commenced	X 4	X 4	X	X	X
	Information officer appointed		X Commenced					
	Display material arranged		X Commenced	X 4	X 4	X	X	X
5.4	Professional development							
	Lecturers appointed: - production - cereals	X 4 X Recruitment underway	X 4Completed X 4Completed					
	Students appointed	X 7/16 commenced	X 17/23 commenced	X 19 students	X additional 7 students	X	X	X
	Tertiary courses developed and presented	X Commenced	X Commenced	X 4	X 4	X	X	X
	Scholarship coordination		X Commenced	X 4	X 4	X	X	X

X = To be completed (in some cases this exercise is spread over several years).

4= Achieved (if not achieved, status provided.)

UTILISATION AND APPLICATION OF THE RESEARCH, COMMERCIALISATION, LINKS WITH USERS

The Rice CRC is committed to ensuring that research is applied throughout the industry. This is achieved by an active education and technology transfer program and by ensuring links are maintained throughout the industry.

In 2000/2001 rice was produced by more than 2,000 growers in NSW and 18 in Victoria. The majority of these enterprises are small production units, but there are now more corporate rice producers. The close linkages in the chain from water supply, through production to processing and marketing components of the industry, facilitates effective utilisation and application of the research.

Rice growers are becoming increasingly aware and pro-active in their involvement in environmental management. It is the responsibility of this CRC to provide objective information to enable producers to meet this increasingly complex challenge. It is important, also, that the Rice CRC works with other organisations to ensure a uniform approach. These links are illustrated in the following table.

Stakeholder	Information	Involvement
Rice producers (2,130 farms in NSW)	Production Sustainability (watertables, salinity, drainage water quality, pest control)	Extension Involvement as advisors at project, program and Board levels Cooperation
Rice organisations -Ricegrowers' Association of Australia -Rice Research & Development Committee	Production Processing Sustainability Policy Research programs	Advice Coordination Coordination
Processors (eg, Ricegrowers' Co-operative Ltd)	Processing Sustainability (pests) Quality Assurance New producers	Involvement in research
Irrigation corporations - Murrumbidgee Irrigation Limited - Coleambally Irrigation Cooperative Limited - Murray Irrigation Limited	Sustainability (watertables, salinity, drainage water quality)	Involvement as advisors Cooperation Rice CRC project participants and collaborators
Agribusiness Companies (chemical and fertiliser distributors)	Sustainability (pest control) Productivity (eg, fertilisers)	Extension Education Involvement in research
Land and Water Management Plan groups	Sustainability (watertables, salinity, drainage water quality) Productivity	Liaison Land and Water Management Plan project committees Education programs
Community	Sustainability Education	Implementation and education Policy involvement

Transfer of information to users

* *Field Days*

The Rice CRC participated in the Henty Field Days (September 2000) and Murrumbidgee Farm Fair (March 2001) and disseminated a variety of information relating to the CRC in general and its projects. CRC staff also participated in the annual Rice Field Days held throughout the rice growing region.

* *Interaction with irrigation companies*

Irrigation companies are an important conduit for environmental management as they are often responsible for environmental monitoring and Land and Water Management Plan implementation. Rice CRC interaction with these organisations is therefore of importance. Projects 1102, 1105, 1107, 1201 and 1403 are excellent examples of interaction with irrigation companies.

* *Interaction with users*

The results of two Masters theses, which were undertaken within a project looking at modelling of salt transport and accumulation in irrigated areas (1401B), were personally presented to co-operating farmer, Mr Peter Stott.

Research from a project looking at remote sensing of irrigated crop types and its application to regional water balance estimation (1105) has been applied by Coleambally Irrigation Cooperative Limited (CICL). The research has made a direct and relevant improvement of increasing the horizontal positional accuracy of the commercially supplied digital air photos to CICL. This has major implications for the accuracy of their baseline GIS database. The issue of positional accuracy has wider implications for Australia's geo-spatial mapping industry and copies of the Rice CRC report were sent to key individuals with the Australian Land Information Group (AUSLIG). From feedback we know that this report has had an impact within AUSLIG.

Dr Shahbaz Khan gave an invited presentation on scaling issues in hydrologic economic modelling for the Sugar CRC in Toowoomba, March 2001. He also presented the Rice CRC's funded work on regional hydrological economic modelling to a catchment scale modelling workshop of the CRC for Catchment Hydrology as an invited speaker (December 2000). Dr Khan gave presentations on groundwater research to Murray Irrigation Board, Murrumbidgee Irrigation Board of Directors, Cadell Land and Water Management Plan and the Irrigation Research & Extension Committee.

Training sessions were held for farmer groups and environmental staff in the Coleambally Irrigation Area about results from project work on optimising agronomic options at the farm scale (1201). Meetings were held with 14 farmers from the Murray Valley to discuss model results and groundwater conditions in and around their farms.

Representatives on the steering committee include environmental managers from Murray, Murrumbidgee, Coleambally, Goulburn Murray Waters and researchers from CSIRO and Department of Land and Water Conservation.

The projects looking at bioremediation of pesticide residues in drainage waters (1303) and enzymatic bioremediation for pesticide residues in irrigation tailing water (1304) have strong interaction with users. Orica Australia Pty Ltd is the licensee and has a large water care business. Research and development on the projects at Orica focuses on production, formulation and implementation issues. Good progress is being made in these areas and the thion OP enzyme has been tested successfully in the field.

Outcomes from Project 2102 (Development of a nitrogen soil test) have been reported at pre-season grower meetings, as well as remote sensing and agriculture conferences.

Project 6201 (Economic evaluation of alternative resource management strategies in a risky environment), aims to evaluate a selection of Rice CRC projects against economic and physical dimensions of sustainability. The project will involve analysing the impact of these selected CRC technologies at the farm and regional levels. This will identify changes in farm and regional incomes and changes in physical dimensions of sustainability such as soil and water salinity, and watertable depths. A large part of the process for achieving the objectives of this project has involved the convening of workshops with research staff and end users such as agronomists, farmers, industry organisations and irrigation companies to collect and collate information and seek feedback.

** Program and project meetings*

Program and project meetings provide an excellent opportunity to link researchers and users of the research. Examples of such meetings were those for Program 1 in December 2000 and Program 5 in July 2000. Specific project meetings were held for Projects 1102, 1201, 1205, 1403 and 2106.

** Newsletters and publications*

The Centre's external newsletter "Rice CRC Update" was again distributed on a quarterly basis to over 2,000 rice growers throughout the Murrumbidgee and Murray valleys.

Electronic delivery was adopted for the quarterly internal newsletter "Rice CiRCle" in March 2001. This publication is delivered to more than 250 Centre participants. Various project participants submit items for this newsletter, in addition to reports prepared by the editor on general matters and CRC projects.

The Rice supplement to the Australian Grain Magazine has also continued to be an important vehicle for transfer of information to users of the Rice CRC results. Occasionally articles on CRC funded work also appear in the general section of the magazine because of their potential relevance to other industries in addition to rice. Articles featuring CRC projects have also appeared in the IREC Farmers' Newsletter, Farming Ahead and the Incitec Fertilizers' Newsletter.

STAFFING AND ADMINISTRATION

The Rice CRC is a geographically distributed organisation with researchers located with the core and associated partners. The administration office is at Yanco Agricultural Institute and is provided by NSW Agriculture.

There was an adjustment to some of the leadership positions during the year.

Prof Paul Burnett was appointed as the Board's representative for Charles Sturt University following the resignation of Prof Kath Bowmer. Prof Kath Bowmer was appointed as the Board's representative for CSIRO Land and Water following the resignation of Dr Graham Harris. Mr Bob Jones was appointed as the Board's "alternative" representative for Ricegrowers' Co-operative Limited. Ms Sulari Goonetilleke was appointed as an independent member on the Board to enhance representation of the interests of downstream Murrumbidgee/Murray users and the ecological system. Mr Warwick Clampett was appointed as the Management Committee's representative for NSW Agriculture following the resignation of Prof Graeme Batten, however Graeme Batten has remained on the Committee representing Charles Sturt University.

The roles and commitments of the specified personnel as at 30 June 2001 are:-

SPECIFIED PERSONNEL			
Name	Participant	% Time	Role
Dr L Lewin	Rice CRC/NSW Agriculture	100	Director, researcher Program 3
Dr E Humphreys	CSIRO Land and Water	60	Leader, Program 1
Prof G Batten	Charles Sturt University	30	Leader, Program 2
Dr E Dennis	CSIRO Plant Industry	20	Leader, Program 3
Dr Y Khatri	Ricegrowers' Co-operative Ltd	30	Leader, Program 4
Dr P Eberbach	Charles Sturt University	20	Leader, Program 5
Assoc Prof S Black ³	Charles Sturt University	0	Key researcher, Programs 2 and 5
Mr A Dunn	Charles Sturt University	15	Key researcher, Program 5
Dr N Darvey	University of Sydney	20	Key researcher, Program 3
Dr B Sutton	University of Sydney	20	Key researcher, Program 2
Dr B Jacobs ⁴	University of Sydney	20	Key researcher, Programs 2 and 5
Dr S Khan	CSIRO –Land and Water	95	Key researcher, Program 1
Mr HG Beecher	NSW Agriculture	35	Key researcher, Programs 1 and 2
Mr P Williams	Ricegrowers' Co-operative Ltd	30	Key researcher, Programs 2 and 4
Mr P Klatt ⁵	Ricegrowers' Co-operative Ltd	0	Key researcher, Program 4

³ Assoc Prof S Black had 0% time for 2000/2001 due to ill health.

⁴ Dr B Jacobs resigned from The University of Sydney and the Rice CRC as at 31/12/2000.

⁵ Mr P Klatt resigned from Ricegrowers' Co-operative Limited and the Rice CRC as at 6/4/2001.

RESEARCH STAFF RESOURCES

Charles Sturt University

Staff Name	Main Activity	% of time pa	% Spent on Research Program (R)					% Spent on Education Program (E)	% Spent on Tech.Tsf Program (T)	% Spent on CRC Admin. (A)
			Program				Tot. on			
			1	2	3	4	Res.			
Dr G Ash	R	20		20			20			
Dr A Katupitiya	R	20	15				15	5		
Dr D Lamb	R	10		10			10			
Dr J Louis	R	10		10			10			
Prof J Pratley	R	10			10		10			
Assoc Prof K Robards	R	10				10	10			
Prof A Robertson	R	10		10			10			
7 research staff less than 10%	R	37.5	5	13.5	5	7.5	31	5	0	1.5
Mr A Dunn	E	15					0	11	2	2
Mr K Eustace	T	10					0		10	
Mr M Win	E	10					0	10		
Prof G Batten	A	30					0			30
Dr P Eberbach	A	20					0			20
Mrs W Cooke	A	12.5					0			12.5
FTSE=		225	20	63.5	15	17.5	116	31	12	66

University of Sydney

Staff Name	Main Activity	% of time pa	% Spent on Research Program (R)					% Spent on Education Program (E)	% Spent on Tech.Tsf Program (T)	% Spent on CRC Admin. (A)
			Program				Tot. on			
			1	2	3	4	Res.			
Dr N Darvey	R	20			20		20			
Dr B Jacobs	R	20			15		15	5		
Dr B Sutton	R	20			20		20			
Prof R Gilbert	R	10			10		10			
5 research staff less than 10%	R	26	0	9	5	5	19	7		
FTSE=		96	0	9	70	5	84	12	0	0

CSIRO Land and Water

Staff Name	Main Activity	% of time pa	% Spent on Research Program (R)					% Spent on Education Program (E)	% Spent on Tech.Tsf Program (T)	% Spent on CRC Admin. (A)
			Program				Tot. on			
			1	2	3	4	Res.			
Dr M Edraki	R	100	100				100			
Ms N O'Connell	R	100	100				100			
Dr S Khan	R	95	95				95			
Dr E Humphreys	R	60	40				40			20
Mr D Robinson	R	48	48				48			
Dr K Spark	R	45	45				45			
Mr A Prasad	R	42	42				42			
Mr B Fawcett	R	25	25				25			
Dr T McVicar	R	25	25				25			
Mr D Smith	R	20	20				20			
Dr E Christen	R	15	15				15			
2 reseach staff less than 10%	R	13.8	13.8				14			
FTSE=		488	468	0	0	0	468	0	0	20

CSIRO Plant Industry

Staff Name	Main Activity	% of time pa	% Spent on Research Program (R)					% Spent on Education Program (E)	% Spent on Tech.Tsf Program (T)	% Spent on CRC Admin. (A)
			Program				Tot. on			
			1	2	3	4	Res			
Dr E Dennis	R	20			20		20			
Dr N Upadhaya	R	20			20		20			
Dr A Chaudhary	R	10			10		10			
Dr R Dolferus	R	10			10		10			
Ms B Sherman	R	10			10		10			
2 reseach staff less than 10%	R	10			10		10			
FTSE=		80	0	0	80	0	80	0	0	0

NSW Agriculture

Staff Name	Main Activity	% of time pa	% Spent on Research Program (R)					% Spent on Education Program (E)	% Spent on Tech.Tsf Program (T)	% Spent on CRC Admin. (A)
			Program				Tot. on			
			1	2	3	4	Res.			
Mrs T Dunn	R	100		100						
Dr R Singh	R	60	30	30						
Mr J Thompson	R	60	55	5						
Dr H Gill	R	50		50						
Dr S Akbar	R	40	40							
Dr L Lewin	R	38			10				28	
Mr G Beecher	R	35	23	5					7	
Dr G Batten	R	30		30						
Mr B Dunn	R	30		30						
Dr R Reinke	R	30			30					
Mr P Snell	R	30			30					
Mr Rob Williams	R	30		30						
Dr M Stevens	R	25		15	10					
Dr E Cother	R	20		10					10	
Dr M Fitzgerald	R	20			20					
Mr S North	R	20	20							
Mr L Evans	E	25				0	15	10		
Mr W Clampett	T	30				0		27	3	
Mr P Beale	T	20				0		20		
9 T/T staff 10 % or less	T	77				0		77		
6 various staff 10% or less	Various	40		5		5	25		10	
	FTSE=	810	168	310	100	0	578	40	134	58

NSW Department of Land and Water Conservation

Staff Name	Main Activity	% of time pa	% Spent on Research Program (R)					% Spent on Education Program (E)	% Spent on Tech.Tsf Program (T)	% Spent on CRC Admin. (A)
			Program				Tot. on			
			1	2	3	4	Res.			
Mr A Van der Lely	R	45	14				14		31	
Mr A Brink	T	52							52	
Mrs J Taylor	T	30							30	
Mr T Spencer	T	20							20	
Mr M Alamgir	T	15							15	
Dr S Joseph	T	11							11	
9 staff with 10% or less	Various	31	4.1				4		24	3.1
	FTSE=	204	14	0.0	0.0	0.0	18	0.0	183	3

Ricegrowers' Co-operative Limited

Staff Name	Main Activity	% of time pa	% Spent on Research Program (R)					% Spent on Education Program (E)	% Spent on Tech.Tsf Program (T)	% Spent on CRC Admin. (A)
			Program				Tot. on			
			1	2	3	4	Res.			
Mr N Cutter	R	71				71	71			
Mrs Y Pan	R	52				52	52			
Mr M Bayles	R	33				33	33			
Mr P Williams	R	30				30	30			
Mr D Hill	R	28				28	28			
Ms K Close	R	15				15	15			
Ms K O'Connor	R	11				11	11			
Dr Y Khatri	A	30					0			30
Dr K Hutton	A	10					0			10
7 staff 10% or less	Various	23				11	11			12
	FTSE=	300	0	0	0	248	248	0	0	52

Other Organisations

Staff Name	Main Activity	% of time pa	% Spent on Research Program (R)					% Spent on Education Program (E)	% Spent on Tech.Tsf Program (T)	% Spent on CRC Admin. (A)
			Program				Tot. on			
			1	2	3	4	Res.			
Dr J Weinman, Australian National Uni.	R	40			40		40			
Prof B Rolfe, Australian National Uni.	R	20			20		20			
Dr Y Shao, Uni. of NSW	R	15	15				15			
Mr S Fukai, Uni. of Qld	R	10		10			10			
Assoc Prof M Wootton, Uni. of NSW	R	10				10	10			
Mr R Robinson, Coleambally Irrigation	T	53	3				3		30	20
Ms T Ginns, Coleambally Irrigation	T	30					5	25		
Ms K Hodgson, Coleambally Irrigation	T	30					5	25		
Mr D Murray, Coleambally Irrigation	T	35					0	10	25	
Ms B Rzeszkowski, Coleambally Irrigation	T	30					5	25		
Mr A Tiwari, Coleambally Irrigation	A	10					0			10
Various staff less than 10%	Various	20	12	3			15	2	1	2
	FTSE=	303	30	13	60	10	113	27	131	32

CRC Funded staff

Staff Name	Organisation seconded from.	Main Activity	% of time pa.	% Spent on Research Program (R)					% Spent on Education Program (E)	% Spent on Tech.Tsf Program (T)	% Spent on CRC Admin. (A)
				Program				Tot. on			
				1	2	3	4	Res.			
Dr C Russell	CSU Wagga	R	100		100			100			
Dr S Sivapalan	CSU Wagga	E	100					100			
Dr C Blanchard	CSU Wagga	C	100			30	5	35	65		
Sub total	CSU Wagga		300	0	100	30	5	135	165	0	
Dr L Cantrill	Syd Uni	R	100			100		100			
Dr X Zhao	Syd Uni	R	100			100		100			
Ms F Chen	Syd Uni	R	80			80		80			
Sub total	Syd Uni		280	0	0	280	0	280	0	0	
Mr T Van Niel	CSIRO L&W	R	100	100				100			
Dr M Bhuiyan	CSIRO L&W	R	75	75				75			
Ms L Best	CSIRO L&W	R	55	55				55			
Ms N King	CSIRO L&W	R	50	50				50			
Mr B Wang	CSIRO L&W	R	50	50				50			
Mr Z Wang	CSIRO L&W	R	50	50				50			
Dr F Zhou	CSIRO L&W	R	50	50				50			
Dr W Quayle	CSIRO L&W	R	25	25				25			
Ms L Short	CSIRO L&W	R	11	11				11			
Sub total	CSIRO L&W		466	466	0	0	0	466	0	0	
Dr P Hughes	CSIRO PI	R	100			100		100			
Ms N Young	CSIRO PI	R	100			100		100			
Dr R Dolferus	CSIRO PI	R	90			90		90			
Sub total	CSIRO PI		290	0	0	290	0	290	0	0	
Mr K Faour	NSWAG	R	100	50	50			100			
Mr T Farrell	NSWAG	R	100		100			100			
Ms K Fox	NSWAG	R	100		100			100			
Mr D Griffin	NSWAG	R	100	100				100			
Mr N Jinadasa	NSWAG	R	100	100				100			
Ms H Shead	NSWAG	R	92			92		92			
Ms V McGrath	NSWAG	R	29		29			29			
19 seasonal staff	NSWAG	R	241	17	205	19		241			
Mr A Sanderson	NSWAG	E	100					100			
Mrs R Troidahl	NSWAG	E	46					46			
Mr M Cook (Communications)	NSWAG	T	100						100		
Mr G Hart	NSWAG	A	100							100	
Ms J Symes	NSWAG	A	100							100	
Dr L Lewin	NSWAG	A	62			5		5		57	
Mrs J Hubatka	NSWAG	A	42							42	
Sub total	NSWAG		1312	217	434	116	0	767	146	100	
Mr R Bowman	RCL	R	50				50	50			
Ms T MacNamara	RCL	R	50				50	50			
Mr P Meline	RCL	R	50				50	50			
12 staff with 15% or less	RCL	R	54				54	54			
Sub total	RCL		204	0	0	0	204	204	0	0	
		FTSE=	2852	683	534	716	209	2142	311	100	299

SUMMARY OF CONTRIBUTION IN PERSON YEARS

	Tot equiv. Person Years	Person years spent on research programs (R)					Person years spent on Education (E)	Person years spent on Comm/ TT (T)	Person years spent on CRC Admn (A)
		Program				Tot. on Res.			
		1	2	3	4				
TOTAL CONTRIBUTED	25.05	7.00	3.96	3.25	2.81	17.05	1.10	4.60	2.31
TOTAL FUNDED BY CRC	28.52	6.83	5.34	7.16	2.09	21.42	3.11	1.00	2.99
GRAND TOTAL	53.57	13.83	9.30	10.41	4.89	38.47	4.21	5.60	5.30
Proportion of total professional staff resources in each activity	1	0.26	0.17	0.19	0.09	0.72	0.08	0.10	0.10

SUPPORT STAFF

NB: The figures below have been extracted from the information above and are therefore not additional research resources

Organisation	Contributed No. Staff (person years)	CRC Funded
Charles Sturt University	0.175	
University of Sydney		0.8
CSIRO Land and Water	1.43	1.5
CSIRO Plant Industry	0.2	1.9
NSW Agriculture	1.3	6.12
Dept of Land and Water Conservation	0.05	
Ricegrowers' Co-operative Limited	0.45	1.54
Other	0.12	
Total	3.73	11.86

See Part D