Value Added Wheat CRC Ltd

ABN 65 070 001 839

Annual Report 2006-07

Established and supported under the Australian
Government's Cooperative Research Centres Programme

Editor: C. Johnson, Value Added Wheat CRC, North Ryde 2113, Australia.

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PARTICIPATING ORGANISATIONS

Value Added Wheat CRC is an incorporated company and operates within the framework of the Commonwealth Cooperative Research program with Participants' cash and in-kind contributions being supplemented by financial assistance from the Commonwealth.

Partners in the Centre are from major wheat-based product manufacturers, commercial, agricultural and research bodies.

CORE PARTICIPANTS

Commercial

Allied Mills Australia Pty Ltd

Arnott's Biscuits Ltd.

Bayer CropScience Pty Ltd

Grains Research & Development Corporation

Research

NSW Dept. of Primary Industries

The Department of Agriculture and Food

The University of Sydney

SUPPORTING PARTICIPANTS

- Diversity Arrays Technology Pty Ltd (DArT P/L)
- George Weston Foods Ltd
- Qld Department of Primary Industries and Fisheries (QDPI & F)
- Food Science Australia (CSIRO)
- South Australia Research and Development Institute (SARDI)
- University of Adelaide
- Austgrains International
- Waratah Seeds
- Australian Centre for Plant Functional Genomics
- AWB International

Vision and Mission

Our Vision and Mission can be summarised in a single sentence:
"The pursuit of excellent science to meet commercial needs for a more profitable wheat industry".

Our Goals are to:

- Combine new science with existing knowledge and technologies to develop new methods of determining quality, process improvements and wheat germplasm.
- Link science to the consumer by integrating the research efforts of several groups into commercially targeted programs.
- Ensure the quickest possible delivery of science to the market place to maximise its commercial impact.

VAWCRC is integrating advanced bioscience, food science, agronomic and genetic investigations, from "research to customer". It is commercialising value added wheat and related products through novel and existing business systems. This involves the co-ordinated development and management of intellectual property associated with:

- germplasm and variety improvement;
- wheat production, handling and storage;
- food manufacture and
- nutritional end product and shelf life qualities.

We are using new science in the areas of:

- genomics, proteomics and molecular genetics;
- molecular markers (including microarrays);
- immunology (including engineered antibodies) and
- advanced analytical methods.

Outputs

- The application of advanced technologies that will permit diagnosis of a range of wheat quality and variety attributes for growers, buyers, handlers and processors of wheat.
- Knowledge, which will provide for enhancement of the processing performance of wheats, and for the creation of new, improved and more profitable products.
- Application of plant genetic research to create germplasm for new wheats with specific high added value uses, and improved quality performance when grown in adverse environments.
- A succession of tertiary and postgraduate educated scientists and technicians with practical experience of wheat quality science.

Executive Summary

Given the Commonwealth's decision not to continue funding a Wheat CRC beyond 30 June 2008, the Board of VAWCRC faced two options. First, we could seek to maintain the continuity of the business through establishing a successor to the Company as a whole. Second, we could seek to maximise the value of the CRC's legacy to the industry, by focusing individually on each project and program and on each of our commercial business activities, positioning each to maximise future industry value.

After careful commercial evaluation, the Board adopted the second of these alternatives. All CRC activities have been reviewed from the perspective of maximising the prospect of future value-creation as at 30 June 2008. Some work has been wound up; some has been accelerated. The ground is being prepared for some business activities to continue under changed ownership, while others will be closed down. All VAWCRC intellectual property and work-in-progress will also be positioned to maximise the prospect of future industry value creation. However the Company - Value Added Wheat CRC Ltd - will be wound up.

Context and Major Developments during the Year

The year in review commenced just after the CRC had heard that it would not get further Commonwealth support after the expiry of the current contract in 2008. The increasing severity of the drought, the corporatisation and rationalisation of public-sector wheat breeding in Australia and the changed influence of AWB on the national wheat research strategy all contributed to a rather difficult environment for a reappraisal of the CRC's research.

An audit of our research was conducted, broadly to determine where the resources that remained in the life of the CRC should be focused to maximise benefit to its shareholders and to the industry. A strong emphasis was on determining what activities and intellectual property could be packaged up for sale or transfer to participants or third parties at the end of the Commonwealth contract. The post of Research Director was put onto a half-time footing, reflecting the current needs of the CRC; nonetheless he has been active in reviewing, ranking and developing strategies to position work-in-progress to continue productively and produce outcomes for the industry.

In overall terms, given the conclusions of the research audit and the CRC's operating environment, the Board-approved actions were as follows:

In Program 1, the valuable Allied Mills Food Innovation Grant project - finding rapid methods for assessing wheat quality of grain silo samples for processing – was continued to the end of the year, as Allied and its commercial partners were using the technology routinely. An orderly wind-down of the main antibody discovery project was undertaken with continuing work focusing on specific antigens and on completing PhD projects. The work on new antibodies produced for WheatRite® and three breeder diagnostic tests was continued in anticipation of transferring the technologies at the end of the CRC.

In Program 2, many of the projects were, in any case, nearing completion at the beginning of the year in review. The Arnott's-driven project on modified atmosphere packaging of intermediate baked goods was showing significant potential application for control of mould growth, so was continued until the year-end. The sponge and dough project aimed at improving the baking quality of Australian wheats was terminated early, as it was judged unlikely that any germplasm would emerge sufficiently advanced by the end of the life of the CRC. Other high-amylose germplasm from Program 2 is probably to be bundled into Program 4 (see below) to be made available for future development. A negotiated project for AWB on the field expression of the defect, late-maturity α-amylase (LMA) did go ahead with a successful outcome.

In Program 3, research for the molecular marker service provided by Triticarte® Pty Ltd has continued to be supported, the major outcome being a published comprehensive map including DArT® markers for wheat. Further investments in equipment, service delivery and information technology (IT) - including statistical research - were made to ensure the consistent delivery of the Triticarte® service. The CRC continued to explore the use of mutagenesis to produce useful quality-related wheat mutants for industry. The GRDC and AWB also supported an examination of the feasibility of providing an LMA screening service for breeders and marketers.

Program 4 adds value to Australian wheat by developing germplasm and varieties with the marketable processing and product traits desired by VAWCRC's partners and stakeholders. The program was therefore continued through the year in relatively unmodified form. Using advanced technologies, the projects target qualities such as soft wheat, waxy wheat, large grain size, low oxidative enzymes, enhanced pre-harvest sprouting tolerance, and extreme soluble carbohydrate contents to improve flour water absorption. Such varieties and traits are important to enhance the total and value-adding opportunities to the Australian wheat industry. They are also an important mechanism by which much of the intellectual property developed within the VAWCRC can be delivered to industry. Our researchers are also developing dual-purpose triticale with resistance to three rusts.

The projects were managed so as to optimise the packaging of their IP (germplasm and finished varieties) into a "speciality wheat improvement program" (SWIP) that could be transferred or sold to an ongoing Australian wheat-breeding program following the end of the CRC's Commonwealth contract. Emphasis was placed on bringing the IP to the point where it could have the highest value to a successor organisation.

The education and technology transfer Program (5) retained its important place in the changed priorities of the CRC, generating a succession of tertiary educated and postgraduate scientists and technicians with practical experience of wheat quality science, plant breeding, analytical and business skills. Indeed

the decisions about terminating or continuing projects (above) were conditioned by the need for students to finish their PhDs. We will achieve our target of supporting thirty postgraduates with industry exposure within the term of the CRC, including the initiative to produce five new wheat breeders for the industry. Additional training in project and people management, presentation skills, intellectual property, commercialisation and occupational health and safety was provided to all students, to enhance their value as future team leaders in the industry. One of our students, Natalie May, distinguished herself by winning the AIFST Jack Kefford Award for best paper in the journal "Food Australia" in 2006. Other awards are listed in Table R5 on page 33.

We continued to achieve effective technology transfer of outcomes of VAWCRC research programs through product and IT development initiatives, publications, workshops, and the development and revision of nationally accredited courses. A project supported by a GRDC grant for coordination and knowledge management relating to nationwide trials of CIMMYT wheat lines in Australia provided an outstanding opportunity for initiatives in technology transfer, and furnished a test-bed to evaluate the stand-alone potential of the scientific work embedded in the CRC when the Commonwealth contract ends. The coordination role provided by the CRC was and continues to be extremely well regarded by industry.

Commercialisation and Utilisation

The Wheat CRC has a strong focus on commercialisation and utilisation of research outcomes, and well developed strategies for achieving it. The aim is to deliver the outcomes as widely as possible to maximise the benefits to partners and the industry in general. Highlights in this area in 2006/07 included:

- Our joint venture wheat and barley genotyping business – Triticarte Pty Ltd – continued to operate well and increased commercial service revenue by 20% on the previous year.
- Increased tonnages of the soft wheat lines QAL2000$^{\phi}$ and QALBis$^{\phi}$ were produced and two new lines QAL1064$^{\phi}$ and QAL3362$^{\phi}$ were licensed and advanced for commercialisation.
- The waxy wheat program continues to be strongly supported as a contract research project by George Weston Foods – a Supporting Participant of the CRC.
- The first commercial unit of the z-arm mixer for mixing and testing small quantities of flour was sold.
- Australian wheat research and breeding programs utilised the CRC's doubled haploid, LMA screening, crown rot testing, mutagenesis and antibody testing services.
- Bayer CropScience maintained its commitment to commercialise the WheatRite® and ReadRite® wheat quality testing technology with continued development and evaluation.
- Two triticale cultivars were advanced for commercialisation.

Important components of the commercialisation and utilisation activities of the CRC include marketing plans, IP management, a communication strategy and end-user involvement - an integral part of the process, as end-users contribute to the development, targeting and management of research projects to achieve required and desired outcomes. This is one of the real strengths of the CRC program.

Financial Management

The CRC has continued to maintain its very high standard of accounting and financial management of the business. The centre operated within budget. All reporting requirements for the Board and Commonwealth were achieved. The external audit of the business reported that no material misstatements or irregularities were identified.

Conclusion

Last year's Annual Report contained an independent, highly complimentary, fifth-year review by Dr Jim Miller who concluded that of the CRC's "projected research and technical outcomes… some have already been achieved and others are well on track for completion in the next two years…This is a very valuable asset for industry and the challenge will be to maintain and build on this base for the future". As described above and throughout this annual report, the management of the CRC in the sixth year of the VAWCRC's life (twelfth since the Wheat CRC began) has been aiming to continue the flow of valuable outcomes from the programs, at the same time reorganising them to enable transfer of the assets to new organisations at the end of the Commonwealth contract, thereby capturing value for the shareholders.

The Value Added Wheat CRC had to refine its operating strategy during 2006/07 given the changing operating boundaries for the business. The CRC is committed to continuing to operate diligently in its final year to meet its Commonwealth, Corporate Governance, Shareholder and operating requirements. The main challenge will be to transfer the research projects and commercialisation activities, which will have high industry pay-off, to organisations that have the capacity, capability and willingness to conduct and continue the work.

NATIONAL RESEARCH PRIORITIES

The research activities of the Wheat CRC are strongly focussed on Australia's research priorities. The calculated percentages in Table 1 are derived from weighting the resources into the different projects of the Centre. Frontier science (including Australian-invented genetic technology) has been widely deployed by the CRC to accelerate the discovery and diversify the use of improved quality wheats for the benefit of the more traditional and mature industries, agriculture and food production. Cultural change in the application of the science through the use of locally targeted bioinformatics has also been an important feature. The smaller percentage contributions to sustainability, health and invasive pests are the result of the effective application of the Centre's advanced science to these areas to produce real tangible improvements, such as the enhanced ability of wheat breeders to cope with climate change and diseases, and the ability of food producers to manufacture products with nutritional or health benefits.

National Research Priorities and Value Added Wheat CRC Research

Table 1:

NATIONAL RESEARCH PRIORITIES	CRC RESEARCH (%)
AN ENVIRONMENTALLY SUSTAINABLE AUSTRALIA – Transforming the way we use our land, water, mineral and energy resources through a better understanding of environmental systems and using new technologies	
Transforming existing industries	5
Responding to climate change and variability	2
PROMOTING AND MAINTAINING GOOD HEALTH – Promoting good health and preventing disease, particularly among young and older Australians	
Preventive healthcare	4
Strengthening Australia's social and economic fabric	2
FRONTIER TECHNOLOGIES FOR BUILDING AND TRANSFORMING AUSTRALIAN INDUSTRIES – Stimulating the growth of world-class Australian industries using innovative technologies developed from cutting-edge research	
Breakthrough science	21
Frontier technologies	17
Advanced materials	34
Smart information use	16
Promoting an innovation culture and economy	25
SAFEGUARDING AUSTRALIA – Safeguarding Australia from terrorism, crime, invasive diseases and pests, and securing our infrastructure, particularly with respect to our digital systems	
Protecting Australia from invasive diseases and pests	7

Highlights 2006-2007

The Wheat CRC's research, commercialisation and education highlights and achievements during 2006-2007 include:

- New, small-scale tests that predict wheat-processing quality were made available to the industry in a Food Innovation Grant project.
- In the same project a rapid, small-scale laboratory method for determining the variety of wheat deliveries reached the point of commercial exploitation.
- A working antibody array and an antigen array for use in diagnostic tests for wheat quality were created.
- A rapid, disposable field-test for the identification of waxy and Udon noodle wheat using immunology was demonstrated.
- A commercial WheatRite® product manufacturing protocol was finalised by a CRC participant. Patent protection in the United States was added to that in Europe and other countries.
- The occurrence of the "late-maturity amylase" wheat quality fault was surveyed in Australia and reported to industry.
- Commercial production and sale of the first small-scale laboratory instrument to measure dough quality.
- The usefulness of modified atmosphere packaging to control mould growth in intermediate-moisture baked goods was validated for a commercial product.
- Over two thousand DArT® molecular markers were mapped and sequenced providing previously unavailable coverage of the wheat genome.
- Triticarte® profitably supplied increased numbers of molecular marker assignments to wheat and barley breeders worldwide.
- Several new assays valuable to breeders were developed for potential to offer as services, nation-wide (disease and fault susceptibility assays).
- Methods of bringing about specific changes in genes for quality (resistant and waxy starch and hardness) have been demonstrated in Australian wheat varieties.
- The initial characterisation of exotic synthetic germplasm (from CIMMYT) for use by Australian breeders was coordinated, rationalised and put on a more scientific basis.
- Wheat germplasm with elevated resistant starch (having health and processing benefits) was isolated, characterised and its genetics elucidated.
- New sources of disease resistance (*Septoria tritici* and *Staganospora nodorum*) were characterised genetically and introduced into breeders' material in eastern and western Australia.
- Germplasm for hard and soft wheat varieties was identified, with novel qualities such as (high fibre) resistant starch and consistent granule size, and it was characterised genetically.
- Bread and noodle wheat germplasm with novel qualities and comprehensive disease resistance, two or three years from release, was identified.
- A new waxy wheat variety was put into commercial production.
- Over 20,000 tonnes of soft biscuit wheats were grown in commercial production in eastern Australia and overseas, and two new soft wheats were released.
- Two triticale cultivars also reached commercialisation stage.
- The CRC reached its targets for postgraduate training especially of wheat breeders. Over 250 registrants attended industry workshops and technical training for students.
- Successful technology transfers occurred; particularly to breeders Australia-wide to assist development and uptake of the CRC's marker assisted selection in wheat.
- Coordinaton and knowlege management relating to nation wide trials of CIMMYT wheat lines extremely well-regarded by the industry.

Membership, Function and Meetings of the VAWCRC Governing Board

The majority of the Centre's Core Participants are represented on the Board (Table 2.1). Directors bring a balance of skills in business and science to the Centre (their individual qualifications are outlined further later in this section). They establish the strategic direction of the Centre, set performance benchmarks for scientific, commercial and operational activities and monitor performance against these benchmarks. Meetings are held each quarter throughout the year.

The Managing Director

The Managing Director is a member of the Board and is responsible for the management of the Centre on a day to day basis. He provides leadership to the Centre, ensures that funds are used in accordance with the budget in the Annual Operating Plan and monitors the Centre's performance. He is also responsible for the Centre's commercialisation activities and for monitoring the company's Business Plan and ensuring that its objectives are met. He reports to the Board at its regular meetings.

Research Director

The Research Director monitors activities in the research program, directs the Senior Management Group, and identifies new research opportunities. He works closely with the Managing Director in directing the overall research activities of the Centre.

Table 2: Specified Personnel

2.1 CEO and Governing Board Members

Name	Organisation	Position / Role
Dr Geoff Miller	Independent	Chairman
Mr Peter Vaughan	VAWCRC	Managing Director
Mr Cameron Miners	Allied Mills Australia Pty Ltd	Sales Manager - Commercial
Dr Michael Depalo	Arnott's Biscuits Ltd	Director, Regulatory Affairs, Asia Pacific
Mr Greg Skinner	Bayer CropScience Pty Ltd	Commercial Manager - Diagnostics
Mr John Harvey	Grains Research & Development Corp.	Executive Manager, Varieties
Dr Nick Austin (resigned 5 January 2007)	NSW Department of Primary Industries	Deputy Director General, Primary Industries Science & Research
Dr Stephen Thomas (appointed 23 February 2007)	NSW Department of Primary Industries	Director, Rural Innovation, Primary Industries Science & Research
Prof Les Copeland	University of Sydney	Dean, Faculty of Agriculture, Food and Natural Resources

2.2 Program Managers

Name	Organisation	Position / Role
Program 1: Dr Neil Howes	University of Sydney	Associate Professor, Plant Breeding
Program 2: Ms Di Miskelly	Allied Mills	Research and Development Manager
Program 3: Dr Peter Sharp	University of Sydney	Professor, Molecular Plant Breeding and Director, Plant Breeding Institute
Program 4: Mr John Oliver	NSW Department of Primary Industries	Research Leader, Cereal Genetics and Improvement
Program 5: Ms Clare Johnson	VAWCRC	Manager, Education and Technology Adoption
Other Specified Personnel		
Dr William Rathmell	VAWCRC	Research Director
Mr Bruce Sparey	VAWCRC	Finance Manager

Senior Management Group

The four Research Program Managers, Education and Training Manager, four other senior representatives of Core Participants (who advise across all programs), the Research Director and the Managing Director make up the Senior Management Group.

The Program Managers, who have appropriate technical and commercial qualifications, are responsible for the timely and effective management of all projects allocated to each Program and reporting on them to the Managing Director and at SMG meetings. Routinely, meetings are held monthly (and at other times when required).

2.3 Extended Senior Management Group Members

Name	Organisation	Position / Role
Ms Felice Driver	Bayer CropScience Pty Ltd	Research and Development Manager, Diagnostics
Dr Richard Brettell	Grains Research and Development Corporation	Manager, Germplasm Enhancement
Mr Andrew Kennett	Arnott's Biscuits Ltd	Strategic Ingredients Coordinator
Dr Michael Francki	Department of Agriculture and Food, Western Australia	Manager- Biotechnology

Intellectual Property (IP) Committee

The IP Committee monitors the intellectual property arising from the Centre's research and identifies outcomes that require protecting by patent or trademark or other means. The committee consists of the Senior Management Group, senior project managers and a patent attorney. It meets approximately every twelve to fifteen months.

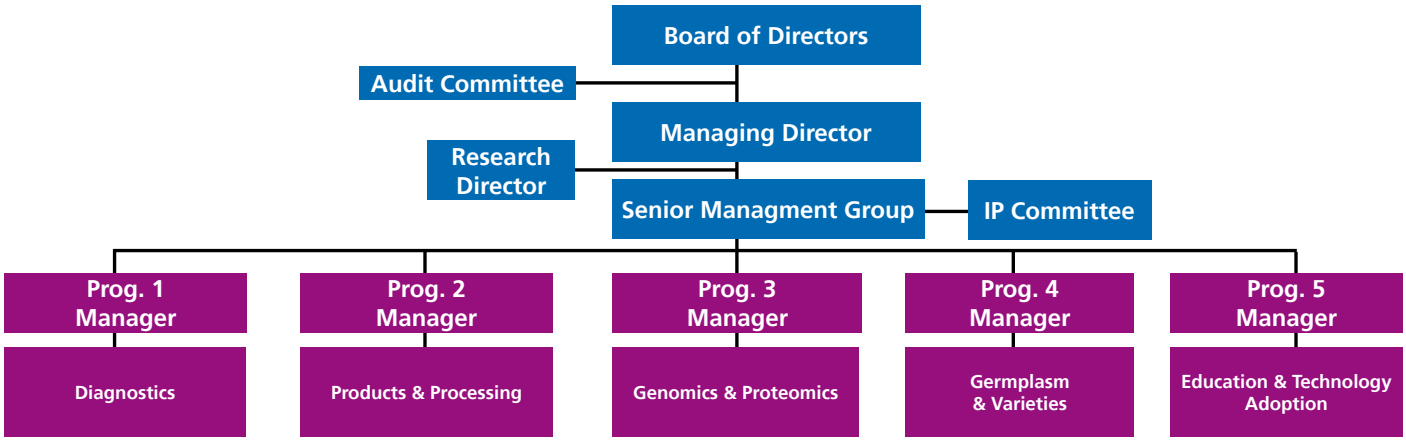
Audit Committee

The Audit Committee (drawn from members of the Board of Directors) reviews the financial reports of the company and the results of the annual audit. It reports its findings to the Board.

Changes in Membership

A Deed of Variation and Novation was executed by the Commonwealth to allow Bayer CropScience Australia Pty Ltd to assume the rights and obligations of C-Qentec Diagnostics Pty Ltd. Thus C-Qentec has retired from the CRC and Bayer CropScience has become a Core Participant in the CRC.

Figure 1. VAWCRC Organisation Chart



Board of Directors

Dr Geoff Miller AO, Chairman, Value Added Wheat CRC Ltd

Dr Geoff Miller's experience spans agribusiness, corporate finance, international trade and government.

During the past decade he was, inter alia, Chairman of Gresham Rabo Management limited (Manager of the Food and Agribusiness Investment Fund); the International Food Policy Research Institute (Washington DC); Beeline Technologies Pty Ltd and The Farmshed Ventures Pty Ltd.

Dr. Miller has also served on the Boards of Agrilink, Namoi Cotton, Queensland Sugar, AIDC Ltd, the Australian Wool Corporation, the Australian Wheat Board and the Australian Centre for International Agricultural Research. He continues as a Director of JEM Bonds Ltd and as Chairman of Value Added Wheat CRC Ltd. He also has been Principal of a corporate advisory business. In this capacity he has been advisor to a number of leading agribusiness CEOs.

Earlier in his career, Geoff Miller spent almost two decades as Chief Executive of Australian Government agencies in Canberra. He was, inter alia, Secretary of the Department of Primary Industries and Energy, Associate Secretary of the Department of Foreign Affairs and Trade, Director of the Economic Planning Advisory Council and Director of the Bureau of Agricultural Economics. In the mid 1990's, he became a fellow of the Australian Institute of Company Directors. He is also a recipient of the Australian Centenary Medal for Public Service, a Distinguished Alumnus Award from the University of New England and an Australia Day Medal. He is a Distinguished Fellow of the Australian Agricultural and Resources Economics Society and an Honorary Life Member of the Australian Nuffield Farming Scholarship Association. He was awarded an AO in the Order of Australia in 1993 for his services to Primary Industry.

Dr Miller graduated Bachelor of Agricultural Economics with first class honours from the University of New England and Master of Arts and Doctor of Philosophy in Applied Economics from the Food Research Institute of Stanford University (USA). He is an alumnus of Farrer Agricultural High school, which has named a building in his honour.

Mr Peter Vaughan, Managing Director, Value Added Wheat CRC Ltd

Peter holds an MBA from Macquarie University and a B.Agr.Sc. from the University of Melbourne.

Appointed in February 2002 as Value Added Wheat CRC's Commercial Director, Peter succeeded Professor Bill Rathmell as Managing Director on 1 October 2005. Peter brings a strong commercial focus to the MD role, building on his existing responsibility for commercialisation and management of intellectual property developed in the CRC (including wheat germplasm and varieties).

He has a key role in developing strategic alliances with organisations (core partners, supporting participants and external) to finance and conduct the development and commercialisation of VAWCRC's research outputs. His activities span negotiation of research contracts and commercialisation agreements, management of the intellectual property portfolio and register and maximising revenue through commercial activities.

He is involved in the planning and management of research conducted by VAWCRC to meet the requirements of core partners and other stakeholders, and in development and implementation of VAWCRC's business strategy, reported at Board level. Peter also had a key role in the establishment and operation of Triticarte Pty Ltd.

He lends his business skills and experience in the plant variety development and commercialisation industry to his role as Business Development Manager for this VAWCRC joint venture company with DArT P/L, aiming to make Triticarte the preferred supplier of genotyping services to the wheat and barley breeding programs in Australia.

Previously, he held the positions of Cultivar Manager (National role); Regional Manager (Victoria, South Australia, Tasmania) for SGB Australia Pty Limited (1999-2002) and Licensing and Marketing Manager, Agricultural Licensing Australia Pty Limited (1992-1999).

Board of Directors

Dr Michael Depalo, Director Regulatory Affairs, Asia Pacific, Arnotts/Campbells.

Michael Depalo graduated from the New South Wales Institute of Technology in 1986 with a Bachelor of Applied Science in Biotechnology and the Institute Medal. He commenced work at McCorquodale Stock feeds, a Division of Arnott's Milling, as an Analytical Chemist where he was responsible for quality testing of raw materials including wheat, barley, sorghum and a range of milled products and blended feeds. From the Arnott's Milling Division he transferred to the Arnott's Research Centre where he managed the Analytical laboratory and was responsible for analytical support to Product Development and nutrition analysis of finished products. Moving into Microbiology, Michael gained his PhD in Biotechnology from the University of New South Wales for work done on the development and elucidation of the continuous lactic fermentation of flour for use in fermented crackers and breads. In this role he did extensive work with the BRI and also the New South Wales Department of Agriculture Research Institute in Wagga Wagga. In 1999 he moved to Product Development where he was responsible for the Sweet and Chocolate categories and was instrumental in the development and range extensions of many icon products.

He is currently the Director of Regulatory Affairs for Campbell Arnott's Asia Pacific responsible for compliance and regulatory affairs. Michael is a member of the AIFST and sits on the Science and Technical Committee of the Australian Food and Grocery Council.

Professor Les Copeland, Dean, Faculty of Agriculture, Food and Natural Resources, Sydney University

Les Copeland graduated from the University of Sydney with a BSc (Honours) and a PhD in Biochemistry. After postdoctoral research in the USA, at Yale University, New Haven and the State University of New York, Buffalo, he took up an academic appointment in the University of Sydney, where he has been since 1974. He was Head of the Department of Agricultural Chemistry and Soil Science from 1993 to 2000, and since 2001 has been Dean of the Faculty of Agriculture, Food and Natural Resources. Professor Copeland was a Fulbright Fellow in the University of California in Davis, USA in 1979-80, and a Visiting Fellow in the Australian National University in 1986 and 1992.

He has over 120 publications, including more than 70 peer-reviewed journal articles, and has supervised 25 completed PhD candidatures. He is a Fellow of the Royal Australian Chemical Institute, and a member of the Editorial Board of Plant Science. Professor Copeland's research and teaching cover agricultural, food, plant and environmental chemistry and biochemistry. His main current research interests are concerned with the chemistry and biochemistry of starch and proteins in cereal grains. He has extensive experience in all aspects of academic leadership and management, and is a member of the Research Advisory Committee of the Australian Farm Institute, and Chair of the Management Advisory Committee of the University of Sydney Holtsbaum Agricultural Research Institute.

Mr John Harvey, GRDC Executive Manager, Varieties

John is accountable for managing all aspects of the GRDC's investments in the "better varieties, faster" pathway, including gene discovery, germplasm development, breeding, variety commercialisation and variety testing. Currently, this includes expenditure of about $60M pa, 220 projects and 40 different R&D partners within Australia and overseas. John has over 17 years experience in the Australian grains industry. John joined the GRDC in 1997 as Program Manager, Farming Systems and was promoted to Executive Manager, Program Operations in 2001.

He commenced his current role in February 2005. Prior to joining the GRDC he was Industry Manager with the Queensland Department of Primary Industries based at Kingaroy. John is a Graduate member of the Australian Institute of Company Directors and in addition to the VAWCRC, John is a director of Australian Crop Accreditation System Limited, member of the board of the Graingene joint venture and past Director of the CRC for Plant Based Management of Dryland Salinity

Board of Directors continued

Mr Greg Skinner, Business and Development Manager, Bayer CropScience Pty Ltd

Greg Skinner has over 20 years experience in agriculture, with a background in plant nutrition and crop protection. He has tertiary qualifications in both Agricultural Science and Business Management (Agribusiness).

From 1995 until 2000, he held the position of Product Development Manager with Rhone-Poulenc (now Bayer CropScience), having national responsibility for field research and development activities across a range of crops. He then took his current role of Business Development Manager with C-Qentec Diagnostics Pty Ltd, a subsidiary of Bayer Crop Science, formed to commercialise diagnostic tools for agriculture. His responsibilities include commercial, marketing and technology transfer functions.

Mr Cameron Miners, Allied Mills Pty Ltd Sales Manager - Commercial, Allied Mills

Cameron Miners has spent the past 22 years within the flour milling industry. The first 15 years of his career was within flour milling operations managing mills across Australia and the Pacific.

Cameron has spent the past 7 years managing Allied Mills relationships with its strategic partners, which include the majority of Australia's icon food manufacturers.

Dr Nick Austin, Deputy Director General, Science & Research, NSW Department of Primary Industries (Resigned 5/01/07).

Dr Austin obtained a BE (Agr) Hons and PhD from Melbourne. He is a Graduate of the Australian Institute of Company Directors and the Australian Rural Leadership Program, and is a Certified Irrigation Designer. He researched irrigation management in the dairy, rice and horticulture industries in the Victorian Department of Agriculture before moving to New South Wales to lead the Water Use Efficiency Unit for NSW Agriculture. Subsequently, he was appointed the Department's Executive Policy Analyst. For several years he held the position of Director, Rural Innovation with the NSW Department of Primary Industries. This Branch comprises the Department's genetics and breeding programs for cereals, pastures, pulses, oilseeds, sheep and beef, as well as research programs in biotechnology, climate science and precision agriculture.

Dr Austin is a member of the NSW Agricultural Advisory Council on Gene Technology and the *ad hoc* Committee on Plant Genetic Resources in Agriculture. Dr Austin currently holds the position of Deputy Director General, Primary Industries Science & Research. He was appointed to the Board of Directors of the Cooperative Research Centre for Value Added Wheat and to the Centre's Audit Committee in November 2004 (and in 2005 to Chairman of the Audit Committee).

Dr Stephen Thomas, Director, Rural Innovation, NSW Department of Primary Industries (Appointed 23/02/07)

Prior to joining NSW Agriculture in 2002, Steve was employed as a post-doctoral research fellow responsible for establishing and overseeing genomics programs both in Copenhagen, Denmark and Perth, WA. He has fulfilled biotechnology roles within NSW Agriculture, now NSW Department of Primary Industries. In these roles, he co-ordinated the NSW Government interaction with the Office of the Gene Technology Regulator regarding environmental releases of genetically modified organisms, was the Executive Officer of the NSW Agricultural Advisory Council on Gene Technology and remains a member of the NSW Farmers Association Biotechnology Taskforce. He also supervised the Department's biotechnology unit, undertaking research predominantly into plant molecular genetics. Since April 2006, Steve has been the Director of the Rural Innovation Branch, which undertakes research into genetics and improvement of beef, sheep, pastures, pulses, oilseeds and cereals.

RESEARCH ACTIVITIES AND ACHIEVEMENTS

PROGRAM 1: DIAGNOSTICS

Program Manager: Dr Neil Howes

The focus of Program 1 is on development of diagnostic methods and tools for monitoring wheat and wheat products, at all stages of the supply chain, with an emphasis on "rapid on-the-spot testing". These tests include measures of quality traits such as starch properties, enzymes and proteins that influence dough properties or end product quality.

A major focus has been to provide a rapid test for variety identification. In project 1.1.1, we have demonstrated the value of fast protein separation using "Lab-on-a-Chip" for wheat and barley variety identification by grain handlers; this analysis is now also in use by industry. A number of promising small-scale predictive tests have also been evaluated. In project 1.1.2, we have produced new antibody-based diagnostic tests for wheat and triticale starch quality, and are testing new quality-associated protein targets, designing immunogens and producing appropriate monoclonal and polyclonal antibodies to aid in their detection. This project also places strong emphasis on supervision of a number of postgraduate students enrolled at Sydney University, and their training in the innovation process. In project 1.2.3, we are delivering diagnostic test kits or performing tests on a fee-for-service basis. This project also supports the preparation of specific components for commercial tests delivered by industry partners. In project 1.4.4, we have demonstrated both antigen and antibody-array-based platforms that can be used for improved hybridoma and germplasm screening. While we have demonstrated the potential of a range of diagnostic tests in a laboratory setting, it has proven more challenging to adapt these tests to a reliable "rapid, on-the-spot" format.

Program Aims

Research and development in this program addresses specific industry needs we have identified for diagnostic tests, including:

- Tests appropriate for breeders, enabling early-generation testing of thousands of lines for specific traits that influence end-use quality.
- Tests that can be performed at seed distribution points and on farm.
- Tests that can be performed at grain delivery points in the value chain (silos and processors) to monitor variety purity and environmental influences on quality.

A key outcome is commercialisation of the tests to ensure their uptake, in consultation with the relevant industry bodies at each step. Significant progress has been made in tests for starch quality appropriate for breeders' screening of early generation lines, and for variety identity that can be performed at grain delivery points.

Project No: 1.1.1

Project Title: Protein-composition Analysis
Project Leader: Dr Ian Batey

Background and Objectives

Value can be added to wheat by identifying and segregating loads that suit specific processing needs at country grain storage silos rather than at the mill. Diagnosis should be for genotype and for the specific quality trait. Genotype is most readily identified by analysis of grain-protein composition, and microfluidics capillary electrophoresis methods have the potential to provide very rapid characterisation. Dough strength is the primary trait required by Allied Mills. Development of suitable methods would permit the rapid identification of distinct loads suiting the requirements of specific customers. Traceability measures would be necessary to ensure that grain parcels, once identified for specific uses, can be transported, identity-preserved, to the target mill or customer.

Progress

Variants of the swelling index of glutenin (SIG) test were the best predictors of processing quality in both hard and soft wheats. Soft-wheat samples showed good relationships, not complicated by protein content, to Rmax for both SIG tests. Sedimentation volume and PQV were related more closely to extensibility. All aspects of the Food Innovation Grant with Allied Mills and GrainCorp have thus been completed, and the final report has been compiled.

A Lab-chip DNA analysis to differentiate closely related varieties of wheat and barley has been developed to supplement protein analysis in this platform. Monsanto, South Africa is taking up the Lab-Chip for varietal identification, and ABB (former Australian Barley Board) will use it routinely for this year's wheat and barley harvests. Omega gliadin levels detected by the Lab-Chip were found to be an indicator for sulphur deficiency, now of interest to European millers as a cause of low extensibility. Full details on the use of Lab-chip DNA analysis to differentiate closely related varieties of wheat and barley have been provided in a confidential VAWCRC Report.

Project No: 1.1.2

Project Title: Antibody Diagnostics

Project Leader: Dr James Chin

Background and Objectives

Antibody-based immunoassay is rapid, high-throughput and cost-effective for wheat genotyping and phenotyping by detecting variety- and quality-specific protein markers. These advantages are not shared by other molecular diagnostic methods such as electrophoresis and PCR, which are low throughput and generally require specialised laboratory facilities and trained operators. The primary objective of Project 1.1.2 is the development of immunodiagnostic reagents for the wheat industry, using a combination of novel strategies that fall into five areas: identification of protein targets, characterisation of targets, design of immunisation protocols, design of innovative hybridoma screening protocols and evaluation of monoclonal antibodies (MAbs) in a range of potential diagnostic applications. Emphasis has been placed on production of a panel of MAbs against the isoforms of granule-bound starch synthetase (GBSS) of various *Triticum spp.* due to the importance of GBSS in determining starch quality characteristics.

Progress

PhD student Tuyen Vu is characterising serpins from 12 diploid, tetraploid and hexaploid ancient *Triticum spp.* and has started work to generate MAbs against the serpin variants, to enable screening for polymorphisms (Figure 1.1 (a) and (b)). Another PhD student, Peter Schofield, has established that MAb-based methodology is useful as a complementary tool to DNA-based methods for phenotypic screening of breeding lines. The wheat lines from a Ventura TILLING (Targeting Induced Local Lesions in Genomes) program have been screened using MAbs specific for GBSS 7A, for GBSS 4A and for GBSS 4A/7D, respectively. A total correlation is obtained between the GBSS expression as detected by MAb-based immunoblotting or ELISA and the GBSS cDNA detected by PCR. A third PhD student, Samar Shenouda, is focussing on beta amylase genes from both barley and wheat using the same wild relatives, in addition to the Vulcan x Kewell and Glenlea x Westonia populations. She is performing quality testing to identify lines varying in starch swelling power, preparatory to marker analysis.

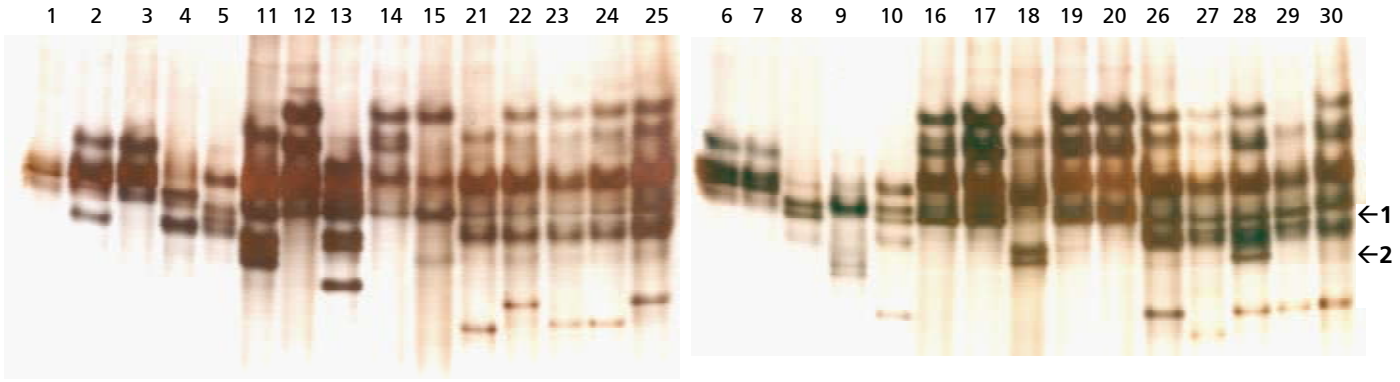


Figure 1.1 (a): Characterisation of serpin polymorphisms amongst *Triticum spp.* by native PAGE. Sequential DTT extracts of diploid (lanes 1-10), tetraploid (11-20) and hexaploid (21-30) *Triticum spp.,* characterised by native PAGE. Serpins and β-amylase have the same pI on native PAGE and are bound together. Bound β-amylase (arrow 1) and fast-moving β-amylase (arrow 2) can be distinguished by zymogram **(Figure 1.1 (b)).**

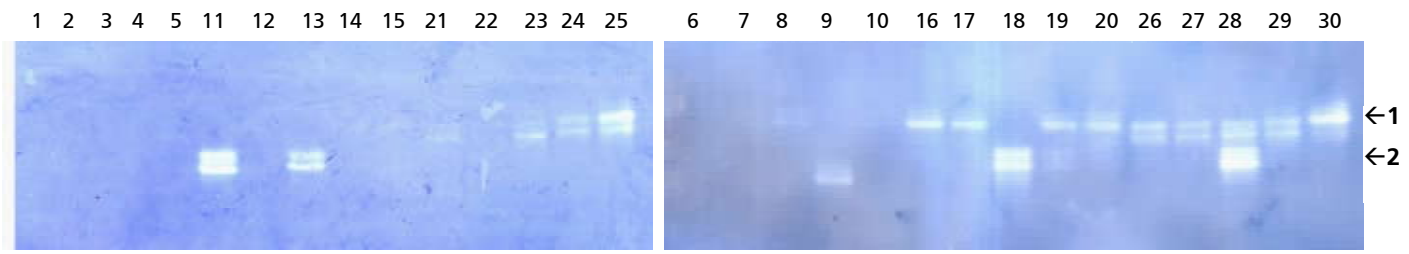


Figure 1.1 (b): Zymogram showing β-amylase activity amongst *Triticum spp.*

Project No: 1.2.3

Project Title: Diagnostics Delivery

Project Leader: Ms Felice Driver

Background and Objectives

The aim of the project is to develop commercial antibody-based diagnostic test kits for use by breeders, and for use in quality assurance monitoring throughout the grain production, supply and processing chain where the identification of specific wheat varieties and quality traits is desirable. The emphasis is on rapid 'on-the-spot' diagnostics to satisfy industry requirements for high throughput testing without the need for laboratory support. Test kits are designed to measure attributes such as variety identity, economically important defects and valuable quality traits such as starch properties or those conferring dough strength. Developments in antibody technologies and test delivery platforms will be deployed to enable simultaneous detection of quality traits in a single test kit.

Progress

A prototype rapid, disposable field test was developed in lateral format for identification of waxy wheat and GBSS null 4A wheat phenotypes. Work is in progress on screening and epitope mapping the anti-GBSS MAbs to evaluate capture and detector roles. We are also screening the library of anti-amylase MAbs for candidate detector antibodies, and to identify capture MAbs to replace the need for polyclonal antibody manufacture for the LMA and WheatRite® test kits. Three of the MAbs screened to date appeared to target epitope hot spots on alpha-amylase, which, although they experience steric hindrance from polyclonal capture antibody, making them unsuitable candidates in a detector role, may function well as capture MAbs in sandwich reactions. This would still be a good commercial outcome.

Project No: 1.4.4

Project Title: Development of Diagnostic Platform 2

Project Leader: Dr James Chin

Background and Objectives

Our experience in projects 1.1.2 and 1.2.3 has indicated a need to develop alternative platforms with the capacity to visualize multiplex antibody-antigen interactions. The current project was thus initiated. Diagnostic Platform 2 is aimed at the development of glass slide-based microarrays for antibody screening and variety identification. Nitrocellulose-coated microscope slides are printed with an array of antibodies and the patterns of antigen capture are characterised. This format has worked for our colleagues in research with a panel of monoclonal antibodies directed against human leukocyte antigens. The VAWCRC project will attempt to adapt this format for the detection of wheat cultivar antigens using a polymorphic family of proteins as a model for proof-of-concept testing.

Progress

Masters student Stephen McKay has successfully printed a GBSS antibody array and an antigen array for antibody screening, with the help of the Ramaciotti Center, UNSW. The antigen array has been developed using protein extracts from 80 different wheat varieties. The array is being applied to hybridoma screening. It is expected that specific MAbs can be obtained using this high capacity screening methodology. The antibody array was prepared by tethering MAb 1F2 (GBSS 7A-specific), MAb 1C1 (GBSS 4A-specific) and MAb 2H9 (GBSS 4A/7D-specific) onto nitrocellulose-coated slides using a goat anti-mouse Fc antibody. The array has been used in screening GBSS null lines. The screening result has demonstrated that all the antibodies in the array detect their target GBSS isoforms with no cross-reactivity.

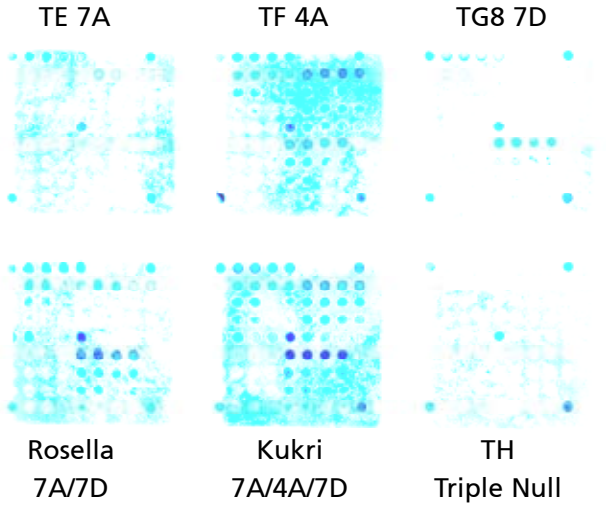


Figure 1.2 GBSS antibody titration array. Distinct patterns observed for each of the three GBSS isoforms.

Major Achievements and Outcomes for Program 1 in 2006-2007

- Variants of the swelling index of glutenin (SIG) test predict processing quality in both hard and soft wheats.
- Lab-chip DNA analysis to differentiate closely related varieties of wheat and barley has been fully developed.
- A rapid, disposable field test developed in lateral format for identification of waxy wheat and GBSS null 4A wheat phenotypes.
- A GBSS antibody array and an antigen array for antibody screening successfully printed.

Table 3: Research Outputs and/or Milestones

3.1:Research Project 1.1.1: Protein Composition Analysis

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 1.1.1.1	Determine predictive tests for processing quality in hard and soft wheats.	03/07	Yes		
Output 1.1	Final Report for FIG grant project	06/07	Yes		
Milestone 1.1.1.2	Develop Lab-chip DNA analysis to differentiate closely related varieties of wheat and barley	06/07	Yes		
Output 1.2	Extend Lab-chip analysis to industry	06/07	Yes		
Output 1.3	Final Lab-chip project report	06/07	Yes		

3.2: Research Project 1.1.2: Antibody Diagnostics

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 1.1.2.1	Characterise serpins from ancient *Triticum spp.*	06/07	Yes		
Milestone 1.1.2.2	Generate MAbs against the serpin variants	12/07	No	Not yet due	
Milestone 1.1.2.3	Screen wheat lines with MAbs specific for GBSS 7A, GBSS 4A and GBSS 4A/7D, respectively.	06/07	Yes		

3.3: Research Project 1.2.3: Diagnostics Delivery

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 1.4	Develop a field test for identification of waxy and GBSS null 4A wheat.	12/06	Yes		
Milestone 1.2.3.1	Evaluate Abs for potential capture and detector roles	08/07	No	Not yet due; in progress	

3.4: Research Project 1.4.4: Development of Diagnostic Platform 2

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 1.4.4.1	Visualise detection Ab-GBSS-capture Ab complexes on arrays	06/07	Yes		

PROGRAM 2: PRODUCTS AND PROCESSING

Program Manager: Ms Di Miskelly

This year has been a busy one for Program 2 as many of the projects are either nearing or have reached completion. Modified atmosphere packaging (MAP) of intermediate baked goods has been shown to have significant application for control of mould growth. The model developed allows industry to predict shelf life according to packaging and gas composition. There has been significant progress in work on development of high amylose wheats and characterisation of amylose complexes, and two of our PhD students in this project are at the stage of completion. Another PhD student, Thu McCann, in her recently submitted thesis, has added to our knowledge on the occurrence of lipids in gluten and flour and the structure of the gluten matrix. A project aimed at improving the baking quality of Australian wheats, in particular the sponge and dough baking system used extensively in Asia, has pinpointed significant differences between cultivars relating to glutenin composition and dough rheology and protein content. Unfortunately, the ending of the VAWCRC next year has meant that this project will be terminated early, but we are negotiating for continuation of the work elsewhere. A negotiated project on the field expression of the defect, late-maturity α-amylase (LMA) has confirmed that the variety Reeves expresses LMA under all conditions.

Program Aims

Most of the projects in this program involve close collaboration with industry partners, working on ideas of mutual interest and providing outcomes of interest to industry. The aims of this program are to generate knowledge:

- for the enhancement of the processing performance of wheat and flour
- for the creation of new and improved products.

Project No: 2.1.9

Project Title: Gluten Structure and Modification for Ingredient Use

Project Leader: Dr Ian Batey

Background and Objectives

Baking is the largest end-use of wheat flour milled in Australia, followed by starch and gluten production. Most of the gluten is exported, and some is used in the domestic market for food applications, for example as a bakery ingredient or as an additive in food production. Gluten enhances the sensory and textural attributes of a range of products.

The major portion of this project involving industrial application of a modified salt washing process has been completed. A PhD project by Thu McCann on the nature of the lipid-protein and protein-protein interactions in gluten complexes continued during the reporting period.

Progress

Investigation focussed on lipid extractability in flour and gluten and the lipid and protein distribution in acetic acid-fractionated gluten. Most of the non-polar lipids originally present in the flour were retained in the gluten. Acetic acid treatment weakened the hydrogen bonds between gliadin and glutenin components in the matrix, resulting in separation of these proteins at relatively low acid concentrations. Non-polar lipids associated with glutenin through hydrophobic interactions. The lipid components were entrapped within the matrix, contributing to its structure and integrity. Glycolipids associated with glutenin through hydrophobic interactions and hydrogen bonds. Phospholipids occurred in higher proportions in protein fractions containing high levels of gliadins, demonstrating that phospholipids probably interact with either gliadins or lipid-binding proteins within the gluten matrix (Figue 2.1).

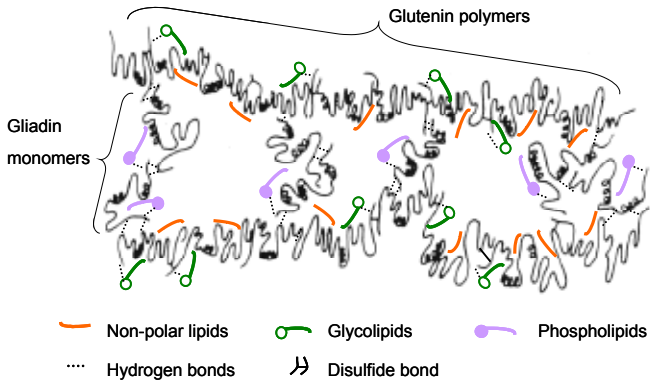


Figure 2.1: Proposed model of protein-lipid interaction in gluten, based on proposed structure of gluten complex, after R. Lasztity (1986, "Wheat Protein", The Chemistry of Cereal Proteins, 19-138 Boca Raton, Florida, USA, CRC Press.

Project No: 2.3.11

Project Title: Predicting Shelf Life of MAP Baked Goods

Project Leader: Dr Ailsa Hocking

Background and Objectives

Market opportunities exist for preservative-free, intermediate-moisture baked goods, but the limiting factor is mould growth. Modified atmosphere packaging using low oxygen and elevated carbon dioxide levels provides potential for extended shelf-life. However, the combinations of low oxygen and elevated CO_2 most effective in inhibiting particular fungal species must be determined over the range of water activity values found in intermediate-moisture baked goods.

The aims of this project are to determine the most effective gas and water activity combinations using a model system based on agar media, and to generate a sufficient body of data to produce a predictive modelling tool for use by the baking industry to design new products and packaging options.

Progress

The effect of modified atmosphere packaging (MAP) on the growth of seven moulds important in the spoilage of bakery products was investigated. Atmospheres of low oxygen in combination with elevated CO_2 were tested over a range of water activity. Although each mould responded differently, the efficacy of modified atmospheres increased with increased percentages of CO_2 in the headspace gas and reduced water activity values in the growth media. The concentration of oxygen was also very important. Mould growth was inhibited completely over the 100-day incubation period when an oxygen absorber was incorporated in the pack. The modelling tool developed predicts shelf-life, given product water activity and packaging system (gas mixtures).

Project No: 2.4.13

Project Title: High Amylose Wheats - Breeding, Nutrition and Interactions

Project Leader: Dr Les Copeland/Dr Matthew Turner

Background and Objectives

The aims of this project, largely undertaken by four of our PhD students, are to produce well-adapted hard and soft wheats with higher amylose contents than are currently available, and to characterise them. Starches from high-amylose wheats have properties enabling their use in films and in food products, where they are a source of dietary fibre and resistant starch. Although high amylose contents exist in other cereals, no high-amylose wheats have been released to date. Their advantage will be that protein functionality will be retained. There is also the potential to deliver nutraceutical constituents of higher quality in increased proportions. We are using material developed in the breeding program in further nutritional studies and to explore starch-lipid interactions using advanced analytical and microscopic techniques.

Progress

Promising population "OA24" with low starch swelling power (SSP) has been scored for rust resistance genes and used in QTL analysis. SSP, a highly heritable trait, is being used for indirect selection for amylose content.

A mouse model has been developed to predict glycaemic response in humans. PhD student Alex Eng has studied the impact of 3 weeks exclusive low glycaemic-response wholemeal diets on enteric microbiota, physiological condition and intestinal tissues. Average blood glucose levels between test groups were not significantly different from control ($P>0.05$).

Isolated A-and B granules of normal, high amylose and waxy starch are being evaluated in studies on the influence of granule size on the formation of starch lipid complex. The B granules have higher SSP values when compared with both A-type and the parent starches. In X-ray diffraction (XRD) measurement of total crystallinity of starches, a clear V-pattern is observed when starch-lipid complexes are isolated and dried, but an amorphous pattern is obtained at higher moisture content. No significant differences in crystallinity of fractionated starches were observed using XRD, whereas initial small angle X-ray scattering revealed differences in the lamellar structure of the two types of granules. There was no systematic difference between amylose content of A- and B-granules measured by iodine binding and the Megazyme assay kit.

While the kinetics of α-amylase digestion of granular starch correlated significantly with swelling power of flour, there were only minor differences among starch varieties after gelatinization. Digestion of gelatinized starch complexed with added lipids was affected by the quantity of lipid-complexed amylose present in native starch. Although amylose retrogradation is slowed by the added lipids, lipid-complexed amylose is less available to α-amylase than free amylose.

Project No: 2.5.21

Project Title: **Improved Downstream Processing using Different Genotypes & Ingredients**

Project Leader: Dr Ian Batey

Background and Objectives

Bread improvers are complex mixtures used commercially to enhance a range of dough processing and end product quality attributes. A precise knowledge of the function of each component is required in order to optimise performance and avoid unnecessary dosage, which incurs a significant associated cost. Knowledge of how improvers and their components react with different types of wheats may lay the basis for better design of improvers.

The aim of the project is to investigate a variety of interactions that occur in wheat based products, including glutenin-improver, improver-improver, wheat protein-ingredient and wheat protein-ingredient-improver interactions.

Progress

The test baking method used in this study is based on the Australian rapid dough process. An optimised baking procedure and lean formulation were first devised and repeatability determined in order to create a baseline for reliable comparison of the effect of added improvers. The procedure involved adherence to important process variables, including mixing to the optimum level of dough development (20% past peak) and proofing to a controlled height.

Using the optimised method, the effects of individual bread improver components and mixtures, including various gluten protein-modifying oxidants, reductants, enzymes and emulsifiers, on dough processing and final product quality attributes were assessed. Parameters measured were rheological dough properties, dough microstructure, dough mixing requirements, and final product quality attributes such as loaf volume, crumb softness and resilience (TA-XT2), crumb colour (Minolta), internal cell structure and loaf shape (C-Cell).

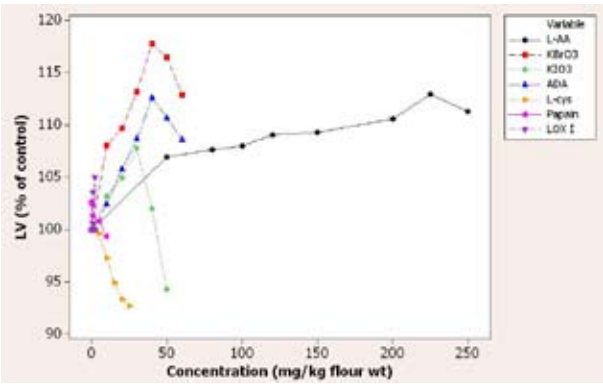


Figure 2.2: Effect of different concentrations of bread improver components on loaf volume of bread

Project No: 2.5.23

Project Title: **Baking Quality of Australian Wheat Varieties**

Project Leader: Mr Geoffrey Cornish

Background and Objectives

Breads are made from Australian wheats using a variety of methods, including long fermentation (LF), sponge and dough (S&D), rapid dough and mechanical dough development. This range of methods has evolved to suit the needs of industry in different countries and the different wheat types available.

The aim of this project is to improve the baking quality of Australian wheat varieties, by comparing loaf volumes of a range of germplasm using a number of different test baking protocols and identifying chemical and rheological variables that influence loaf volume. Further, the project aims to produce germplasm with superior S&D loaf volumes and identify QTL using Triticarte's DArT® genotyping service.

Progress

Results for the 2005 Kukri/Janz DH population were analysed. Average S&D loaf volumes were higher than those from long fermentation. Puroindoline (Pin) type did not affect S&D loaf volume, height, score or colour. Flour protein strongly affected all parameters measured except loaf colour. S&D loaf volume was affected by the Glu-D1 and Glu-A3 alleles, with Glu-D1d alleles giving slightly higher loaf volume than GluD1-a, and Glu-A3b slightly higher than Glu-A3d alleles. There were no interactions.

Flour or rheological measurements with potential to predict S&D or LF loaf volume are flour protein, mixograph height (peak, 3-min or 5-min), and extensibility. Similar results were obtained from the varieties set. Ranking of varieties was very similar in both bake methods, with the varieties Annuello, Carnamah, Diamondbird and Glaive producing highest volume per unit protein in both the LF and the S&D method.

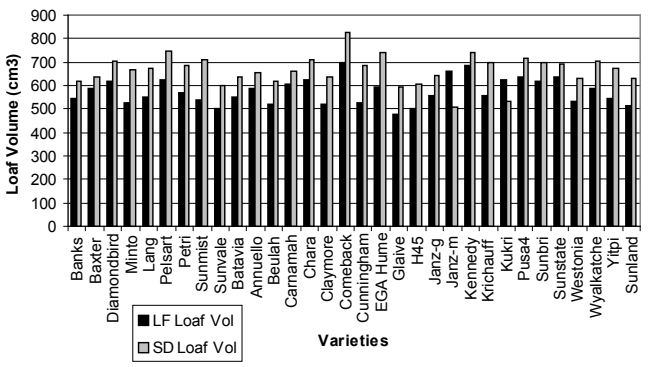


Figure 2.3: Loaf volumes obtained from a number of varieties using the Long Fermentation (LF) and Sponge and Dough (SD) Baking Methods.

Project No: 2.6.24

Project Title: LMA Field Expression Screening

Project Leader: Ms Di Miskelly

Background and Objectives

Grain traded on the domestic and international market is subject to minimum Falling Number specifications. Late-maturity α-amylase (LMA) is a genetic defect of wheat that results in sub-standard Falling Numbers, in the absence of pre-harvest rain and under cool temperatures during ripening. Some varieties currently in production in Australia have the potential for LMA expression and all new varieties are now screened for this prior to release. The LMA Steering Committee has been working with AWB and the industry to consider the issues in current LMA screening, develop targets for varieties pre-release and identify research issues for assessment of LMA and its expression in the field. The aim of this negotiated project was to generate data on field expression of LMA in susceptible varieties during the 2005/06 season and to determine the relationship between ambient temperature post-flowering and LMA expression.

Progress

National Variety Trial samples that had Falling Numbers below 350 seconds were tested for LMA expression. Of the samples that expressed LMA without sprouting, 86% were the variety Reeves. Most of the other LMA-susceptible varieties did not express LMA under any of the degrees of cold exposure experienced in the trials. Samples that expressed LMA, but also had high levels of sprouting, may be problematic in definitively identifying LMA. This group included the LMA-prone varieties Reeves and Kennedy. Small but significant correlations were observed between the number of LMA-expressing seeds and the total hours exposure to temperatures below 16°C, with stronger correlations for total hours below 12°C. Results suggested that cold night temperatures rather than daylight temperatures induced LMA, but more work is required to test this hypothesis. There were no correlations between cold temperatures and LMA expression for Reeves, confirming that this variety expresses LMA in all environments.

Major Achievements and Outcomes for Program 2 in 2006-2007

- Modified atmosphere packaging (MAP) boundary model developed and validated for intermediate-moisture baked goods.
- Flour protein, mixograph height and extensibility predictive of loaf volume in sponge and dough and long fermentation processes.
- High amylose line identified and developed.
- Starch swelling power found to be a highly heritable trait.

Table 3: Research Outputs and/or Milestones

3.5: Research Project 2.1.9: Gluten Structure and Modification for Ingredient Use

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 2.1	Develop a model for lipid-protein interactions	30/12/2006	Yes		
Milestone 2.1.9.1	Write and submit thesis	30/6/2007	Yes		

3.6: Research Project 2.3.11: Predicting Shelf Life of MAP Baked Goods

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 2.3.11.1	Data acquired for preliminary MAP model	30/10/2006	Yes		
Output 2.2	Model validated and report finalised	30/12/2006	Yes		

3.7: Research Project 2.4.13: High Amylose Wheats – Breeding, Nutrition and Interactions

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 2.3	Develop rust resistant line with high amylose content	31/12/2006	Yes		
Milestone 2.4.13.1	Establish relationship between in vivo and in vitro GI estimations on 10 wheat cultivars	30/6/2007	Yes		
Milestone 2.4.13.2	Examine properties of starch-lipid complexes formed from different wheat varieties and assess their susceptibility to enzymic digestion (influence on GI)	30/6/2007	Yes		

3.8: Research Project 2.5.21: Improved Downstream Processing using Different Genotypes and Ingredients

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 2.5.21.1	Collect wheat samples of varying glutenin subunit composition	30/1/2007	Yes		
Output 2.4	Baking method optimised	31/3/2007	Yes		

3.9: Research Project 2.5.23: Baking Quality of Australian Wheat Varieties

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 2.5.23.1	Best S&D DH lines of Kukri/Janz and Glenlea/Westonia determined	30/1/2007	Yes		
Output 2.5	Loaf volume under different baking protocols established	30/1/2007	Yes		

3.10: Research Project 2.6.24: LMA Field Expression Screening

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 2.6.24.1	Complete testing of split seed α-amylase determinations	30/10/2006	Yes		
Output 2.6	Report on relationship between LMA expression and cold temperature exposure	28/2/2007	Yes		

PROGRAM 3: GENOMICS AND PROTEOMICS

Program Manager: Professor Peter Sharp

Program 3 has continued to provide outputs in the area of advanced tools and services for wheat breeders. The array-based wheat polymorphism profiling service (DArT®) provided by Triticarte Pty Ltd has continued to be supported, with the major outcome being a published comprehensive map including DArT® and microsatellite markers for wheat. Statistical research was undertaken in order to provide better analysis methods for DArT® arrays, which will allow a higher quality, and quantity, of data to be collected. We are continuing to use mutagenesis to produce useful quality-related wheat mutants for industry. Using TILLING (Targeting Induced Local Lesions in Genomes), a modified ethyl methane-sulphonate (EMS) mutagenesis and high-throughput SNP detection method was established. As proof of principle, wheat waxy mutants were produced using this method, and these are potential commercial lines, or new parental material. Other suitable mutation detection methods have been studied for effective detection of SNPs in polyploid species such as wheat. A final area of output is the examination of the feasibility of providing an LMA (late maturity α-amylase) screening service for breeders.

Program Aims

The focus of the program is currently on three main strategies to provide tools and services to wheat breeding and genetics programs. The first is use of TILLING to produce new mutant alleles of quality-related genes. If new alleles can be found with extra benefits to end-users, this technique would make them available in adapted backgrounds with "built-in" DNA markers. The second strategy is continued provision of high throughput array-based whole-genome profiling by Triticarte Pty Ltd, and associated research to upgrade the service. The third area is our investigation of the feasibility of providing an LMA (late maturity α-amylase) screening service for breeders. This defect has been determined to be important by industry.

Project No: 3.1.3

Project Title: Mutagenesis of Wheat Grain Characteristics

Project Leader: Professor Peter Sharp

Background and Objctives

The aim of this project is to develop mutagenesis technology for wheat using high throughput genomic tools. Wheat genomics is providing information on a large number of genes of interest that are potentially related to wheat quality. Modification of these targets would produce predicted benefits in wheat processing properties. The method previously explored, oligonucleotide-directed gene repair, has proven not suitable for application in wheat. A new method, 'TILLING' which uses high-throughput mis-match detection to screen wheat populations in which the genes of interest have been EMS-mutagenised, has been adopted for this project. It has resulted in identification of a number of useful mutants of the screened genes during the reporting year.

Progress

Homozygous truncation mutants of puroindoline (pina, pinb) and the waxy character (Wx-A1 and Wx-D1) were identified in mutagenised QAL2000$^{\phi}$ and Ventura populations. Knockout Wx-A1 and Wx-D1 QAL2000$^{\phi}$ mutents (both being null Wx-B1) were crossed, and the F1 projeny selfed. Waxy seeds in the F2 population, identified by iodine staining, were in the expected ratio of 1:15 (waxy: non-waxy) (Figure 3.1) and are now in seed increase. Difficulty was encountered in screening for starch synthase II, a gene related to high amylose content, as the three homoeologous copies of this gene are highly identical. Initial results from screening of the three genes simultaneously by a new method, dideoxy polymorphism, were encouraging, so optimisation of that protocol will continue. EMS-treated populations of Wyalkatchem, WAWHT2750 and Ventura were also established as part of our collaborative research with the Australian Centre for Plant Functional Genomics.

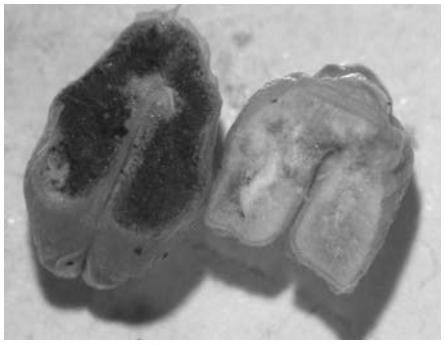


Figure 3.1. Waxy QAL2000$^{\phi}$ (right) was produced by crossing two mutants produced and identified in the TILLING population. Normal QAL2000$^{\phi}$ at left has dark iodine staining.

Project No: 3.4.5

Project Title: **Markers, Mapping and Triticarte**

Project Leader: **Professor Peter Sharp**

Background and Objectives

The aim of this project is to continue to provide Triticarte's DArT®-based high throughput marker service efficiently to internal and external customers, and also to provide Triticarte information to the wheat science community. Wheat breeders and geneticists require cost effective generation of genotyping information on markers with known chromosomal map locations, and the Triticarte service now provides this.

Progress

The Triticarte service has provided DArT® genotyping analyses of over 8,500 wheat lines (cultivars, germplasm sources, genetic populations, breeders' populations), thereby generating over a million data points for the customers. New service formats at a variety of densities requested by the customers are in advanced stages of development. Distribution of Triticarte information to the science community has involved two aspects. The first was the publication by staff from this program, in collaboration with others, of the Cranbrook/Halberd population genetic map, which has 339 RFLP, SSR and AFLP markers, 71 STM markers and 339 DArT® markers, in Theoretical and Applied Genetics in 2006. The second was the release on the Triticarte web-site of an alignment of maps of 8 other crosses with the Cranbrook/Halberd map. This enables the community to see the coverage of the whole wheat genome now achieved by Triticarte Pty Ltd. For barley, a high-density map linking DArT® markers to SSR, RFLP and STS loci and agricultural traits was constructed by Triticarte staff and others, and was published in BMC Genomics in 2006. The consensus map was assembled from individual maps of seven doubled haploid populations and three recombinant inbred lines.

Project No: 3.5.7

Project Title: **Evaluation of Statistical Algorithms in DArT®**

Project Leader: **Dr Alison Smith**

Background and Objectives

DArT® is a computation-intense technology which produces vast amounts of high quality genotype data. These data are managed, stored and analysed using DArTSoft and DArTdb. Both of these use simple but effective statistical algorithms that would benefit from statistical review, since, in the first 11 months of the wheat and barley genotyping service at Triticarte, 2.4 million data points were generated. With a significant increase in demand for DArT®, it had become increasingly apparent that an evaluation of the statistical algorithms would benefit end-users. The benefits would be improved accuracy and throughput, as well as better tools for users to store, manipulate and analyse the data. Through this project, we undertook an evaluation of all statistical aspects of the DArTSoft computer environment.

Progress

A mixture approach to the identification of polymorphic clones is being investigated, and a new statistical technique for the purpose of outlier identification, which is a key problem for DArT® data (and indeed any data), has been developed. A paper currently in preparation describes the methodology, applies the technique to a previously published example and reports the results of the performance of the method in simulation studies conducted to examine type I error rates and false discovery rates. The method performs very well. It is very computationally efficient so that it can be applied quickly and easily to large data-sets such as those generated in DArTSoft. The paper will be submitted to a high profile statistical journal.

Project No: 3.6.8

Project Title: **LMA Testing Service**

Project Leader: **Professor Peter Sharp**

Background and Objectives

The aim of this project is to provide an LMA testing service to Australian wheat breeders on a commercial basis, with support from GRDC for the first 2 years. LMA has been identified as a major problem for Australian wheat breeding programs. The methodology and knowledge developed by Dr Daryl Mares while at the University of Sydney and the University of Adelaide has been provided to the project, and we are maintaining liaison as knowledge develops. Plant growth and cold treatment facilities have been established to enable year-round delivery of the service.

Progress

The facility was ready in December 2006 and the LMA Ring Test was performed to validate the assay in our organisation. The issues identified will be addressed via a quality assurance process. We note that design of the assay itself is also under review and developments over the next year in this project, Dr Mares' laboratory and our new project 4.7.14 may address assay design issues. Apart from the six Ring Test samples, four breeding programs submitted samples for LMA screening during 2006. In addition, 459 selected lines were submitted as part of GRDC's CIMMYT initiative in project 5.5.8, and results will be available early in the 2007-2008 financial year.

Major Achievements and Outcomes for Program 3 in 2006-2007

- TILLING has been proven to be an effective method, allowing a considerable number of waxy QAL2000[b] variants to be produced.
- Knockout mutants of Pin-a and Pin-b were identified and confirmed at the protein level.
- The Triticarte® service is now on a very sound basis, with large volumes of chromosomal location information available to customers.

Table 3: Research Outputs and/or Milestones

3.11: Research Project 3.1.3: Mutagenesis of Wheat Grain Characteristics

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 3.1.3.1	New mutagenesis experiments for larger population	Jan 07	Yes		
Milestone 3.1.3.2	Proof of principle of TILLING, waxy wheat produced	May 07	Yes		
Milestone 3.1.3.3	Methods for mutagenesis and high-throughput screening established	July 06	Yes		
Milestone 3.1.3.4	New methods for screening studied	July 07	Yes		

3.12: Research Project 3.4.5: Markers, Mapping and Triticarte

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 3.1	Provide Triticarte services to external and internal customers	As required	Yes		
Milestone 3.4.5.2	Publication of wheat and barley DArT®/STMP maps	April 2006; extended due to delay at journal	Yes		

3.13: Research Project 3.4.7: Evaluation of Statistical Algorithms in DArT®

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 3.4.7.1	Implementation of new normalisation procedure in DArTSoft	August 06	Yes	Normalisation procedure developed but not yet implemented into DarTSoft. Delay will not imp act on other milestones.	
Milestone 3.4.7.2	Implementation of new models for interaction into DArTSoft	June 07	Yes		
Milestone 3.4.7.3	Prototype algorithm and beta version of software for map construction using DArT® markers	June 07	Yes		

3.14 Research Project 3.6.8: LMA Testing Service

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 3.6.8.1	Successful performance of Ring Test	March 07	No	Start date of project meant late sowing which compromised quality.	Evaluate quality assurance measures and repeat in controlled environment.
Milestone 3.6.8.2	Delivery of commercial service	June 07	No	Tests done but validation required	Modify protocol on basis of revised quality assurance measures.

PROGRAM 4: GERMPLASM AND VARIETIES

Program Manager: Mr John Oliver

Program 4 adds value to Australian wheat by developing germplasm and varieties with the marketable processing and product traits desired by the VAWCRC partners and stakeholders.

Program 4 targets issues not likely to be pursued by the other breeding programs in Australia: soft wheat varieties, waxy wheat varieties, varieties with larger grain size, null polyphenol oxidases, enhanced pre-harvest sprouting tolerance, and extreme pentosan contents to improve flour water absorption. Our researchers are also developing dual purpose triticale with resistance to the three rusts.

Such varieties and traits are important to enhance the total and value-adding opportunities to the Australian wheat industry. They are also an important mechanism by which much of the intellectual property developed within the VAWCRC can be delivered to industry.

In 2006-07 outputs from Program 4 research delivered:

- a new waxy wheat into commercial production;
- 20,000 tonnes of soft biscuit wheats in commercial production in eastern Australia;
- new soft wheat cultivars W3362 and C1064 to release stage;
- an encouraging pipeline of soft biscuit wheats including some with low B-starch granules;
- triticale cultivars AT528 and AT574 to commercialisation stage; and
- introgression of new genetic sources of *Septoria tritici* blotch and *Staganospora nodorum* resistance

Program Aims

- To identify new sources of variation for key quality traits.
- To capture the key attributes of that variation in appropriate germplasm that can be utilised effectively by wheat improvement programs or by producing finished varieties with novel traits.
- To develop and utilise molecular tools to assist the introgression of key traits.

The key commercialisable outputs are novel wheat germplasm and associated molecular tools to assist selection for desired attributes, and new wheat varieties with enhanced attributes for target regions, target grades or processors.

Project No: 4.1.1

Project Title: New Genetic Variation and Markers for Quality Traits

Project Leader: Dr Matthew Turner

Background and Objectives

The aim of this project is to identify novel variation, not currently available in Australian common and durum wheat varieties, for economically important quality and processing characters, and to develop molecular markers for loci conferring the extreme phenotypes. To date, this project has identified novel sources of null polyphenol oxidase (PPO) activity and quantitative trait loci (QTL) for sprouting tolerance and late maturity alpha-amylase (LMA). Current targets include QTL mapping (soluble arabinoxylans, LMA and sprouting tolerance in hexaploid wheats, and blackpoint incidence in tetraploid wheats) and identification of markers that are amenable to high throughput genotyping.

Progress

Molecular markers for two independent sources of LMA and for seed dormancy were identified (see Table R1) and validated in breeder's populations. A complex interaction between several loci was found to regulate LMA activity. This research will provide an efficient mechanism for breeders to select against wheats with LMA. Some DArT® markers have been identified for these characters.

Work on markers for soluble pentosans will enable development of high soluble fibre wheats that will confer processing and health benefits. The relationship between the following characters and blackpoint expression is being analysed in developing grain samples: changes in dry weight, total protein, total phenolics, peroxidase, catalase, phenylalanine, tyrosine ammonia lyase and PPO activities (Figure 4.1). Populations that will enable genetic mapping of blackpoint incidence have also been developed. Tetraploid wheat components of the project are being integrated into the negotiations for the National Durum Wheat Improvement Program to be funded by GRDC. The identified extremes in common wheats will be incorporated into elite germplasm in project 4.3.8.

Table R1: Market Discovery for Economically Important Quality Characters

Trait	Marker Discovery
LMA	3 putative QTL in a Nudifinia population, validated in breeder's populations; complex interaction between several loci.
LMA	1 QTL in a Spica population, validated in breeder's populations; complex interaction between several loci
Seed dormancy	2 significant QTL in AUS1408, a white wheat, identified and validated.
Soluble pentosans	Markers being identified in a common wheat population.
Soluble arabinoxylans (hexaploid wheats)	Populations generated.
Reduced blackpoint incidence (tetraploids)	Populations generated.

Figure 4.1 (a)

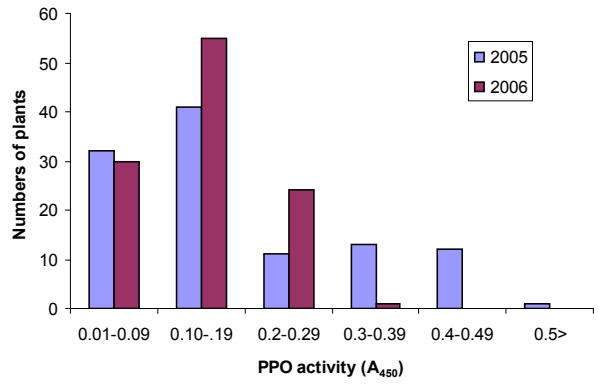


Figure 4.1 (b)

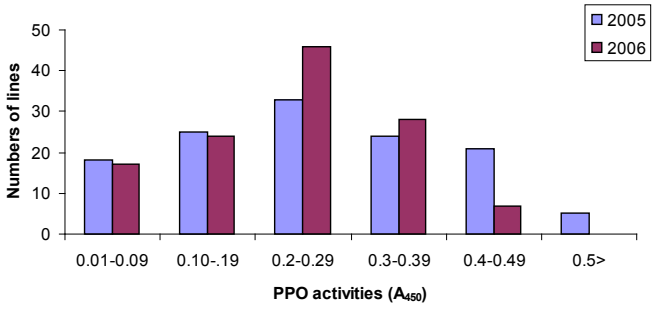


Figure 4.1: Frequency distribution of PPO activity (A450) of (a) Lang x VAW08A17 (null) and (b) QALBis(ϸ) x VAW08A17 in 2005 and 2006 seasons. The null PPO phenotype was conditioned by 2 and 3 genes, respectively.

Project No: 4.1.2

Project Title: **Rapid Breeding Technologies - Novel Adapted Wheats**

Project Leader: **Dr Nizam Ahmed**

Background and Objectives

One of the major objectives of the Wheat CRC is to reduce the time required to develop new varieties. With doubled haploid (DH) technique, homozygosity in breeding lines can be achieved in a single generation compared to the 6-7 generations required in traditional breeding, and thus variety development time can be reduced significantly. The main objective of this project was to establish an efficient DH production technology and produce DH lines on a large scale for the VAWCRC scientists and other external customers.

Progress

Chromosome doubling efficiency in doubled haploid production has been increased in our facility to more than 90%. For the year 2006-07, our target was to produce around 6,000 DH lines. So far, more than 5,000 lines were harvested and delivered to the breeders to assist them in developing new varieties. Harvesting will continue until August. The total number of lines for the year will be around 6,000. Two thousand of these lines were for the external customers and the rest were for Value Added Wheat CRC scientists.

Project No: 4.1.3

Project Title: **Soft Wheat Program**

Project Leader: **Mr Andrew Kennett, Dr Akram Khan and Mr John Dines**

Background and Objectives

The aim of the Soft Wheat Breeding Program is to develop elite soft wheat lines suitable for biscuit and cracker manufacture and for growing in both the eastern and Western Australian wheat growing regions. The program uses advanced germplasm development tools such as doubled haploids and molecular markers along with traditional disease resistance, yield, flour and end product testing to ensure the quality of the developed lines. The lines produced are suitable for PBR registration, AWB classification and competitive commercial release.

Progress

Three lines with yields similar to QAL2000(Ф) in northern NSW and superior to Thornbill, the dominant variety in the MIA, have been progressed to very advanced stages. They performed comparably to the check samples for yield, milling tests, physical dough testing and end-product quality. C1092 and WW3362 have received a preliminary classification of Premium Soft (pending favorable LMA data). WW3362 and C1064 (classified Feed due to low-range extensibility) have been named QAL3362(Ф) and QAL1064(Ф) respectively and are in seed increase prior to commercial release.

Table R2: Trialling of advanced lines

Advanced lines under consideration for release and protection by Plant Breeders Rights. Rust resistance of C1092 is similar to its sister line QAL3362(Ф) but all the other lines are resistant to the three rusts including the newest biotype of stripe rust.	• C1092 (sister line to QAL3362(Ф)) • C41001 biscuit wheat • C51021 biscuit wheat • C41005 possible noodle • C51057 bread wheat • C51049 bread wheat
Lines submitted to National Varieties Trials during 2006-2007	• C41001 • C41002 • C41005 • C51021 • C51040 • C51057 • C51115 • C51128 • C51130

Six other advanced lines are under consideration for release and protection by Plant Breeders Rights (Table R2). A decision on release will be made following 2007 trial results. Production of over 20 kg breeders' seed of each of these lines is underway. Thirty nine S2 lines evaluated for quality have been progressed to S3 trials and S3 samples from 3 of 6 sites are being quality tested at Allied Mills, Toowoomba, for indicative classification by AWB, the remainder being drought-affected. Advanced lines of 6 soft and noodle type and 6 hard types were submitted to the National Wheat Quality Testing Program for evaluation in a range of end products. Although no plots of our selected varieties supplied to the National Varieties Trials (NVT) last year were in fact included in the NVT, 9 lines have been submitted for NVT trials this year (Table R2).

Project No: 4.3.8

Project Title: **Development of Adapted Wheats and Varieties with Novel Characters**

Project Leader: **Dr Matthew Turner & Dr Akram Khan**

Background and Objectives

The objectives of this project include the development of adapted wheat lines and varieties that possess novel extremes of economically important wheat quality and processing characters identified in the Quality Wheat and Value Added Wheat CRCs. Bread wheat germplasm possessing null polyphenol oxidase activity, sprouting tolerance, large grain size (65mg), extremes of water-soluble arabinoxylans and extremes of starch granule size distribution, and tetraploid wheats possessing extremes of starch granule size distribution and low blackpoint incidence, are being used in breeding efforts to incorporate the characters into premium wheats and to generate improved wheat varieties. It is expected that outputs of this project will be incorporated into the national wheat breeding effort.

Progress

Selected breeding lines from a low B-granule wheat x QAL2000(Ф) population, which exhibited high yield in irrigated sites in southern NSW, suitable biscuit quality and high levels of resistance to current rust strains, will be progressed in further trials and subsequently multiplied. A sprout-tolerant line developed in the project yielded slightly lower at Narrabri than current varieties but much higher than the original sprout-tolerant parent, so will also be used in further crossing with elite wheats. Three major QTL associated with the null PPO phenotype were identified (see Figure 4.2). Lines selected from the mapping population, evaluated in field trials last year at Narrabri, are being used as parents in germplasm development. Populations for increased

grain size, high soluble pentosans and sprouting tolerance will be evaluated in the field this year. Some promising candidates for use in further crossing were identified by phenotyping durum populations developed for extremes of starch granule size distribution and for low blackpoint incidence.

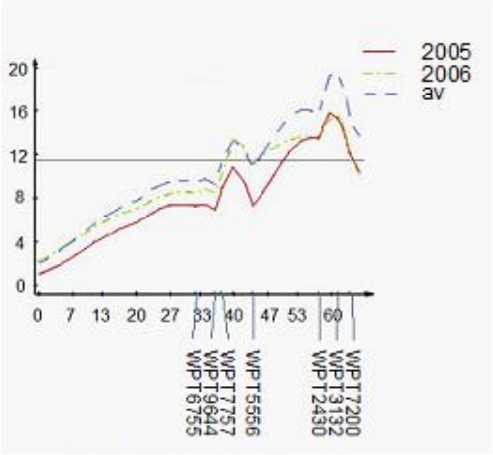


Figure 4.2: An interval map shows the likely position of a QTL regulating PPO activity in relation to DArT® markers along an implicated chromosome region. The results for 2005, 2006 and their average (av) are included. The most likely QTL position is between WPT3132 and WPT2430 where the interval LRS reaches its peak.

Project No: 4.3.9

Project Title: **Marker Validation and Identification for Key Quality Attributes in WA - Adapted Germplasm**

Project Leader: **Dr Michael Francki**

Background and Objectives

Many grain quality parameters to meet specific end-use requirements for the export market are under complex genetic control. Therefore, development of commercial wheat varieties with specific quality parameters requires knowledge of genetic interactions and the ability to track allelic combinations. Markers for genes controlling quality parameters such as milling yield, water absorption, flour b* colour and non-null 4A flour swelling volume (FSV) provide a means by which breeding programs can track allelic combinations. The aims of this project are to identify markers in WA adapted germplasm linked to genes controlling these grain quality traits, and knowledge on genetic interactions controlling quality parameters.

Progress

Major achievements of the project, communicated widely, included the identification of QTL for quality traits consistently detected in multiple environments, and associated DNA markers. The traits include milling yield, non null-4A GBSS flour swelling volume and flour b* colour. Some grain quality parameters such as water absorption were under complex genetic control with strong environmental influences, so their manipulation in breeding remains a challenging task. The knowledge and resources developed in the project are extensive and there is potential to develop an appropriate format to enable breeding programs to efficiently capture and utilise the information. Our use of current varieties and advanced lines from the DAFWA wheat breeding program for population development will facilitate implementation and tracking of alleles in past and future pedigrees, without the need to develop and extensively analyse structured populations using related germplasm.

Project No: 4.3.10

Project Title: **Dual Purpose Triticale - CWQ00011**

Project Leaders: **Dr Norman Darvey, Dr Richard Trethowan**

Background and Objectives

In the expanding triticale industry, farmers of the NSW S-W slopes want dual-purpose varieties for grazing through autumn and winter, followed by a grain crop. Grazing cereals produce twice the dry matter and allow pastures to be rested over the winter. Triticale's tolerance of acid soils and aluminium suits it to this area, and the high demand from local dairy and pig industries, reduced transport costs and higher price make triticale an attractive proposition. We aim to improve grain yield and dry matter production, producing winter triticales for a wider range of sowing dates, improving the grazing habit so that the growing point is closer to the ground, and incorporating new sources of rust resistance. We will also address quality aspects to develop baking-quality triticales for the human food industry.

Progress

Despite the dry conditions in 2006, yield results were very encouraging from the seven mixed cereal trials throughout NSW. AT574 was again the top yielding triticale, yielding twice as much as the triticale varieties Jackie and Breakwell. In most cases it ranked 1 or 2 in comparison to other cereals, confirming it as one of the highest yielding winter type cereals for southern NSW. AT574 and AT528 were increased in 2006 by Waratah Seeds and despite the drought approximately 20 tonnes of seed of each line was harvested. Both lines are being increased in 2007 for commercial release in 2008.

Project No: 4.5.11

Project Title: **Germplasm Development for *Staganospora nodorum* Resistance in Wheat: Genotyping.**

Project Leader: **Dr Michael Francki**

Background and Objectives

Stagonopora nodorum is the major fungal pathogen affecting wheat production in Western Australia. Breeding wheat varieties with enhanced levels of resistance in leaves and glumes is the most cost-effective means for controlling infection in wheat crops. Research at DAFWA and the VAWCRC has identified the genetic control of resistance in leaves and glumes and associated molecular markers to track alleles in wheat germplasm development. The aims of this project are to deploy alleles for resistance that will increase genetic gain in WA-adapted germplasm, and to identify new sources of resistance for breeding commercial wheat varieties with resistance against *S. nodorum*.

Progress

The delivery of at least 50 lines with QTL for leaf, glume blotch or a combination of both resistances in relevant Australian germplasm is on track for successful completion by June 2008, using CIMMYT line 6HRWSN125 as resistance donor and molecular markers associated with 2D leaf resistance and 4B glume resistance QTL. A further six populations are being developed to deploy glume resistance from a winter wheat source using advanced crossbred line P91193D1-10 from Purdue University (a robust QTL, also on chromosome 2D but linked to leaf resistance in 6HRWSN125). BC_1F_1 populations developed using Australian germplasm as recurrent parent are being screened and 50 backcross individuals homozygous for glume blotch resistance QTL from the winter wheat source in relevant Australian backgrounds will be delivered by June 2008.

Alternative alleles for leaf and glume resistance identified in other CIMMYT lines in GRDC-funded sister-project DAW126 will add considerable value to the sources of resistance currently available and to the germplasm being developed. The GRDC-commissioned Marshall-Fellowes report (2006) recognised a continued need for alternative sources of leaf and glume blotch resistance and development of resistant germplasm as high priorities for future investment.

Project No: 4.5.12

Project Title: **Exploiting Resistance to *Septoria tritici* Blotch in Wheat**

Project Leaders: **Dr Andrew Milgate, Dr Harsh Raman and Dr Neroli O'Toole**

Background and Objectives

Septoria tritici blotch (STB) caused by *Mycosphaerella graminicola* (anamorph: *Septoria tritici*), is an important fungal disease of wheat worldwide. STB can cause yields losses of up to 60% in susceptible cultivars in severe epidemics. The control of this pathogen may be achieved by the use of fungicides or by resistance breeding. Genetic resistance is the preferred method of control. This national project is focussed on providing the wheat breeding programs of Australia with the germplasm and genetic resources to help ensure that the Australian wheat industry have the best STB resistant material available.

Progress

The four *Septoria* resistance genes STB 2, 3, 4 and 11 have been combined into six nominated Australian varieties (Ventura, Young, Tammarin Rock, Correll, C643, EGA Gregory) over three crossing blocks, and selected material will be used to produce combinations of five *Septoria* resistances genes in 6 nominated Australian cultivars during 2007.

Trait associations of STB resistance genes with published SSR markers are being validated in Australian germplasm and published SSR markers associated with STB 2, 3, 4 and 11 are being screened across assembled published parental material (Table R3). Twenty four F2 populations have been developed to validate published SSR markers for STB 2, STB 3, STB 4, STB 6, STB 7, STB 10, STB 11 and STB 12.

Table R3: Validation of published SSR markers for *Septoria tritici* blotch

STB 1	Production of a F2 population delayed due to vernalisation requirements of the donor source.
STB 2	Published markers need to be used in tandem for good correlation between the marker and the sources of resistance
STB 3	No banding pattern in published band region
Preliminary results for STB 4	**Good correlation with published sources**
STB5 and STB 8	Sources for resistance are being sought from the publishing author.
Preliminary results for STB 11	**Correlation with sources of resistance over a range of genotypes**

Data from glasshouse seedling screening of 40 sources of Septoria resistance and other lines against a range of isolates (Figure 4.3) has been correlated with field screening and DArT® data to identify potentially novel sources of Septoria resistance. DArT® technology was applied to three DH populations including WW11288 x Rosella and Currawong x CD87 in conjunction with a wide range of different genotypes, including sources of Septoria resistance and parental material from crossing blocks. Four DH populations grown under replicated irrigated field trials at Wagga were inoculated with a mixture of Septoria isolates and scored.

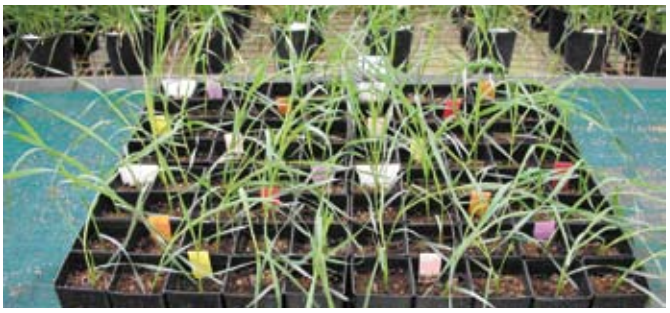


Figure 4.3: Glasshouse screening of wheat for resistance to *Septoria tritici*

Major Achievements and Outcomes for Program 4 in 2006-2007

- a new waxy wheat into commercial production.
- 20,000 tonnes of soft biscuit wheats in commercial production in eastern Australia.
- new soft wheat cultivars W3362 and C1064 to release stage.
- an encouraging pipeline of soft biscuit wheats including some with low B-starch granules.
- triticale cultivars AT528 and AT574 to commercialisation stage.
- introgression of new genetic sources of *Septoria tritici* blotch and *Staganospora* resistance.

Table 3: Research Outputs and/or Milestones

3.15: Research Project 4.1.1: New Genetic Variation and Markers for Quality Traits

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 4.1.1.1	Identify potential markers for LMA and for seed dormancy and assess in breeder's populations.	09/06	Yes		
Milestone 4.1.1.2	Identify markers for soluble pentosans.	12/07	No		
Milestone 4.1.1.3	Develop populations for genetic mapping of blackpoint incidence.	12/06	Yes		

3.16: Research Project 4.1.2: Production of Doubled Haploids

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 4.1	Produce 6,000 doubled haploid lines for VAWCRC breeders and external customers	30/06/2007	Yes		

3.17: Research Project 4.1.3: Soft Wheat Program

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 4.1.3.1	Test advanced lines: agree on strategy to use DArT® information	Oct 2006	Yes		
Milestone 4.1.3.2	Harvest 2006 test crops	Nov 06- Jan 07	Yes		
Milestone 4.1.3.3	Grain and PDT testing of 2006 S2 lines	Feb- July 2007	Yes		
Milestone 4.1.3.4	Selections for 2007 plantings	April 2007	Yes		
Milestone 4.1.3.5	Commence biochemical testing.	July 2007	Yes		
Milestone 4.1.3.6	Grain and PDT testing of 2006 S3 lines	Feb- July 2007	Yes		
Milestone 4.1.3.7	End-product testing of 2006 test crops	June 2007	Yes		

3.18: Research Project 4.3.8: Development of Adapted Wheats and Varieties with Novel Characters

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 4.3.8.1	Cross adapted hexaploid wheats possessing novel characters with elite breeders' lines/ varieties and other novel adapted wheats	31/12/2006	Yes		
Milestone 4.3.8.2	Field evaluate populations of tetraploid wheats segregating for starch granule size distribution	31/12/2006	Yes		
Milestone 4.3.8.3	Conduct field trials – PPO QTL mapping	31/12/2006	Yes		
Milestone 4.3.8.4	Phenotype and genotype populations – PPO QTL mapping	28/02/2007	Yes		
0utput 4.2	Identify QTL – PPO	28/02/2007	Yes		
Milestone 4.3.8.5	Conduct field trials – PPO, LOX, milling yield and YAN quality	31/12/2006	Yes		
Milestone 4.3.8.6	Phenotype and genotype populations – PPO, LOX, milling yield and YAN quality	28/02/2007	Yes		
0utput 4.3	Identify importance of enzymes (PPO, LOX) and milling yield in determining YAN noodle quality	28/02/2007	Yes		

3.19: Research Project 4.3.9: Marker Validation and Identification for Key Quality Attributes in WA-Adapted Germplasm

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 4.3.9.1	Framework genetic map of Cadoux/Reeves with at least 150 SSR and 200 DArT® markers genotyped	30/06/2006	Yes		
Milestone 4.3.9.2	Phenotyping data for quality traits for 2 populations in 3 WA sites completed	31/10/2006	Yes		
Milestone 4.3.9.3	Biometrical analysis and spatial adjustments of data completed	31/11/2006	Yes		
Milestone 4.3.9.4	Identify markers flanking QTL for milling yield, non-null 4A FSV, flour colour and water absorption	30/06/2007	No	Achieved for all traits except water absorption - under complex control that cannot be defined in this study	Milestone met but requires different sources of variation and/or populations for analysis of water absorption
Milestone 4.3.9.5	Identification of molecular markers for each stable QTL	30/06/2007	Yes		

3.20: Research Project 4.3.10: Dual Purpose Triticale – CWQ00011

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 4.3.10.1	New quality characteristics introduced into triticale	12/06	Yes		
Output 4.3	New triticale varieties available	12/07	Yes	seed being increased for ommercial release 2008	

3.21: Research Project 4.5.11: Germplasm Development for *Staganospora nodorum* Resistance in Wheat: Genotyping.

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 4.5.11.1	Validate marker-trait associations for leaf and glume resistance in a 6HRWSN98/ WAWHT2234 population	31/03/2007	Yes		
Milestone 4.5.11.2	Develop 6 BC1F1 populations, select individuals heterozygous for markers linked to leaf and glume resistance	01/07/2007	Yes		

3.22: Research Project 4.5.12: Exploiting Resistance to *Septoria tritici* Blotch in Wheat

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 4.5.12.1	Germplasm with 4 STB genes pyramided into 4 nominated Australian cultivars available for milestone 4.	Original 30/6/2006 Extended 30/4/2007	Yes		
Milestone 4.5.12.2	Marker-trait associations of STB genes 1, 5, 6, 8, 10, 12 validated in Australian germplasm and available for use to achieve milestone 5.	Original 30/6/2006 Extended 30/4/2007	No	Sourcing published variety containing STB 5 and 8. Source of STB 1 Bulgaria 88 is in European winter with limited opportunity to conduct two crossing blocks per year.	Validating F2 populations containing STB 6, 10 and 12 in 2007 using a range of isolates. Sourcing STB 5 (Synthetic 6x) and STB 8 (W7984) through AWCC. Producing F2 population for trait marker association STB 1.
Milestone 4.5.12.3	Genotypic and phenotypic data on Currawong/CD87 and WW11288/Rosella available for analysis	Original 30/6/2006 Extended 30/4/2007	No	Poor phenotypic data for part of the glasshouse screening of Currawong/CD87 doubled haploid population	Currently re-screening doubled haploid population Currawong/ CD87, to be completed by July 2007
Milestone 4.5.12.4	Phenotype and genotype (DArT®, SSR) information of populations from milestone 1 to select germplasm containing 4 STB resistance genes for milestones 5 and 7.	Original 30/6/2007 Extended 30/4/2008	No	F1 material for milestone 1 only harvested in July 2007.	Screening of F1 parent material in spring crossing block using SSR markers will be conducted from July 2007.
Milestone 4.5.12.5	Germplasm from milestones 1 and 2 crossed to produce combinations of 5 STB resistance genes pyramided in 6 nominated Australian cultivars, available for milestone 8.	Original 30/6/2007 Extended 30/4/2008	No	F1 material from milestone 1 harvested at the completion of the autumn crossing block conducted in March 2007.	Crossing block to combine material from milestone 1 and milestone 2 in spring crossing block 2007.
Milestone 4.5.12.6	Phenotype and genotype information of DH populations identified in milestone 3 as containing novel sources of STB resistance.	Original 30/6/2007 Extended 30/4/2008	No	Final analysis of glasshouse and field results in conjunction with DArT® analysis yet to be completed.	Correlation of data for analysis by statistician for identification of regions of interest to pinpoint potential site of interest.

Table R4: Grants for Core Research in the Period 2006-07 and how They Contribute to the CRC

Name of researcher	Researcher's organization	Project for which the grants is awarded	Source of the grant	How the grant contributes to the CRC
Drs Ian Batey, Colin Wrigley and Surjani Uthayakumaran and Ms Di Miskelly	Food Science Australia Allied Mills	Rapid methods to predict wheat quality	Food Innovation Grant *	Extension of original research aims.
Ms Thu Vu	VAWCRC/ Food Science Australia	2.1.9: Gluten structure and modification for ingredient use	Manildra Group	Contribution to postgraduate scholarship.
Dr Chong-Mei Dong	University of Sydney	3.1.3: Mutagenesis of wheat grain characteristics	Australian Centre for Plant Functional Genomics	Share mutagenised libraries for complementary applications by the two organisations.
Dr Eric Huttner et al.	DArT P/L	3.4.5: Triticarte	GRDC CWQ00010	Establishment of the Triticarte genotyping service.
Dr William Rathmell	VAWCRC	3.6.8: Late maturity alpha-amylase screening service	GRDC CWQ00014	Enables establishment of facility and service.
Dr William Rathmell	VAWCRC	4.2.6: Development of Waxy Wheat	George Weston Foods Ltd (confidential)	Utilisation of nevel wheats developed by Quality Wheat CRC Ltd.
Dr Michael Francki	DAFWA	4.3.9: Marker validation and identification for key quality attributes in WA adapted germplasm	GRDC CWQ00013	Supporting phenotyping component for phase II.
Dr Norm Darvey	University of Sydney	4.3.10:Dual purpose triticale	GRDC CWQ00011	Triticale breeding diversifies CRC's germplasm portfolio.
Dr Michael Francki	DAFWA	4.5.11: Germplasm development for *Staganospora nodorum* resistance in wheat: genotyping	GRDC CWQ00009 (DAW126)	Knowledge on the interaction of genes for glume and leaf resistance, and improved germplasm.
Dr Andrew Milgate, Dr Harsh Raman	NSW DPI	4.5.12: Exploiting resistance to *Septoria tritici* blotch in wheat	GRDC CWQ00016	Develop germplasm resistant to economically important disease.
Ms Wendy Newton	Curtin University	5.3.5: Novel process for novel products	Westons Technologies' FIG grant	Path to market, direct industry involvement.
Ms Clare Johnson and Dr Richard Trethowan	VAWCRC	5.5.8: CIMMYT-Australian coordination and communication	GRDC	Opportunity for technology transfer and value addition to industry through coordination and knowledge management skills.

* Awarded to Allied Mills and GrainCorp and overseen by National Food Innovation Strategy, Canberra

Table R5: Awards and Promotions

Name of Researcher	Name of Award/Medal /Prize/ Admission to Academic Institution
Dr Mike Sissons	Appointed adjunct Associate Professor, UNE
Dr Michael Francki	Associate Editor, Genome
Dr Michael Francki	DAFWA Excellence Award, cereal breeding & pathology teams
Natalie May	AIFST Jack Kefford Award
Natalie May, Hayfa Salman, Jaroslav Blazek and Thu Vu	RACI-CCD student awards to attend 2007 Cereal Chemistry Conference
Tuyen Vu	Master of Science in Agriculture
Peter Schofield	Master of Science in Agriculture
Yunxian Mak	PhD

Value Added Wheat CRC Publications 2006-2007

Scientific Journals

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Theoretical and Applied Genetics, 113: 1409-1420.

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Theoretical and Applied Genetics, 112: 1143-1148.

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Trends in Food Science and Technology, 17: 82-90.

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Begum M, Hocking AD, Miskelly D. (2007).
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Research Collaborations

An important success criterion for the Centre is that it promotes research linkages and co-operation amongst its own Participants as well as with outsiders (commercial and public-sector, Australian and overseas). The breadth of collaboration within Wheat CRC projects maintains our high performance in this respect in earlier years. VAWCRC has always benefited from a high percentage of multi-institution, multi-site projects, carrying out the collaborative research required by the wheat industry. Tabular information showing the nature of commercialisation and utilisation of Centre outcomes by end-users - both Participants and non-Participants in the Wheat CRC - is detailed in the Commercialisation and Utilisation section of this Annual Report.

Table R6 charts the participants in all the Centre's research projects during 2006-2007. It is noteworthy that for the first time every single project in the CRC involved at least a two-site collaboration. Out of the twenty-nine projects, only thirteen did not involve a corporation (usually one of the core or supporting commercial participants or Triticarte P/L). Three of the above non-corporate collaborations primarily have an educational

Table R6: Organisation and Project Interactions

	Program 1				Program 2						Program 3			
Project	1.1.1	1.1.2	1.2.3	1.4.4	2.1.9	2.3.11	2.4.13	2.5.21	2.5.23	2.6.24	3.1.3	3.4.5	3.5.7	3.6.8
ACPFG											•			
AGT														
Allied Mills	•							•		•				
Arnotts						•								
AWBI										•				
Bayer CropScience			•											
Cereal Solutions							•							
CIMMYT														
CSIRO FSA	•				•	•		•		•				
Curtin University														
DAFWA														
DArT												•	•	
EMAI, DPI NSW		•		•			•			•				
External clients														
GRDC					•							•		•
IRRI														
Manildra					•									
NSW DPI							•						•	
QDPI&F									•				•	
RACI-CCD														
RMIT					•									
SARDI			•						•	•				
Sydney University	•	•	•	•			•	•	•		•	•		•
Triticarte									•			•		
University of WA														
Waratah Seeds														
Weston Technologies														

nature and involved staff or students located in participant organisations. It should also be noted that, where projects were aimed at producing novel germplasm, corporate partners could only be recorded in a few cases as the majority of the Australian breeding programs with which the CRC interacts are not fully privatised but are dependent on GRDC funding.

Overseas collaborations have continued; the ones with CIMMYT and IRRI having become prominent in the year under review. The ones in the UK with the John Innes Institute and with NIAB (both public-sector) using Triticarte® also continued. Another molecular marker collaboration that became increasingly prominent was with the French multinational Groupe Limagrain. The collaboration with the Wheat Quality Network to evaluate and commercialise our soft wheat germplasm in Argentina also continued.

We conducted joint training activities and continued a research agreement with the Molecular Plant Breeding CRC to contribute to their "Cross Predictor" project.

Program 4									Program 5					
4.1.1	4.1.2	4.1.3	4.2.6	4.3.8	4.3.9	4.3.10	4.5.11	4.5.12	5.1.1	5.1.2	5.3.5	5.3.6	5.4.7	5.5.8
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COMMERCIALISATION AND UTILISATION

The Wheat CRC has well-developed and integrated commercialisation and utilisation strategies and activities for the distribution and adoption of research outcomes. They include intellectual property (IP) management, communication through a variety of media, and involvement of end-users. Each of these elements for the commercialisation and utilisation of outcomes from the Wheat CRC is discussed below.

Commercialisation and Utilisation Strategies and Activities

The following approaches have been used for the commercialisation and utilisation of the Wheat CRC research outcomes – including tangible IP (Patents, Plant Breeder's Rights) and intangible IP (knowledge and know how):

- Licence to CRC Participant
- Licence to external organisation
- Joint venture company
- Contract research/project sponsorship – Licensing Agreement (share of IP developed between sponsor and CRC)
- Commercial fee for service operations
- Conferences, seminars, workshops and forums
- Communication channels

These strategies and activities have continued to prove effective, using the approach appropriate for the relevant research outcome. The aim of the activities is to maximise adoption and increase the impact of benefits for partners, customers and the industry in general.

Progress with the commercialisation and utilisation of outputs from each of the respective research programs in the CRC is detailed below.

Table 4: Commercialisation and Utilisation Strategies and Activities

4.1: Commercialisaton and Utilisation Outputs and/or Outputs and/or Milestones

Program 1 - Diagnostics

Outcome - Provide directly commercialisable outcomes in the form of test kits and test processes

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 1.1	WheatRite/ ReadRite Quality Test System				
Milestone 1.1.1	Provide directly commercialisable outcomes in the form of test kits and test processes	30/06/2008	Yes		Assign licence agreement to Bayer CropScience and discuss and negotiate sale of technology
Milestone 1.1.2	Further product develop-ment by Bayer CropScience	30/06/2007	Yes		Establish new manufacturing capability
Milestone 1.1.3	Continued evaluation and marketing of the system to assist commercialisation	30/06/2008	Yes, ongoing		Continue marketing of product and system in Australia and internationally
Output 1.2	Breeder antibody test kits for LMA, 1B/1R and GBSS-4A				
Milestone 1.2.1	Ensure supply of antibodies and freedom to operate with test kits	30/06/2007	Yes		Maintain supply of antibodies
Milestone 1.2.2	Limited sales of kits	30/06/2007	Yes		Establish ability to deliver test kits on a commercial basis if demand exists
Milestone 1.2.3	Market research to determine commercial viability of product	30/06/2007	Yes		
Output 1.3	LMA screening service				
Milestone 1.3.1	Service established and Ring Test performed for accreditation	30/06/2007	Yes		Continue process of accreditation to deliver service commercially
Milestone 1.3.2	Learning experience for delivery of service	30/06/2007	Yes		Deliver the service
Milestone 1.3.3	Market research to determine commercial viability of product	30/06/2007	Yes		Market the service to industry; explore opportunities to continue post-CRC

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 1.4	Crown rot testing				
Milestone 1.4.1	Offered service on limited basis	30/06/2007	Yes		Market the service to industry
Milestone 1.4.2	Learning experience for delivery of service	30/06/2007	Yes		Deliver the service
Milestone 1.4.3	Market research to determine commercial viability of product	30/06/2007	Yes		Explore opportunities to continue post-CRC
Output 1.5	Protein composition analysis				
Milestone 1.5.1	Completion of research project identifying appropriate tests to predict quality of hard and soft wheats	30/06/2007	Yes		Adoption of outcomes by industry partners

Program 2 – Products and Processes

Outcome - Provide outcomes for utilisation and commercialisation by the CRC's food industry partners and possibly external industry organisations.

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 2.1	Bakery Advisory System - OptiDough™				
Milestone 2.1.1	Commercialise OptiDough™	30/06/2007	No	Limited progress as relevant Core and Industry Partners declined to progress with commercialisation of the technology	Explore potential opportunities to make the technology available post-CRC through sale, assignment or some other transfer
Output 2.2	Gluten extraction technology				
Milestone 2.2.1	Engage with organisations in the gluten industry in Australia and internationally to adopt the technology	30/06/2007	No	Organisations declined to adopt the technology	Explore potential opportunities to make the technology available post-CRC through sale, assignment or some other transfer
Output 2.3	Prediction model for shelf life of MAP products				
Milestone 2.3.1	Develop model for shelf life prediction and continue product development	30/06/2007	Yes		Explore potential opportunities to make the technology available post-CRC through sale, assignment or some other transfer

Program 3 – Genomics and Proteomics

Outcome - Establishment of a joint venture start-up company and a potential service providing genetic knowledge and germplasm for the wheat industry. The outputs of this program will be indirectly commercialised by use in other CRC projects or licensed to other organisations.

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 3.1	Molecular marker genotyping service: Triticarte Pty Ltd				
Milestone 3.1.1	Establish Triticarte® based on markers developed in the CRC using the DArT® platform	01/09/2004	Yes		Continue endeavours to drive business to self-sustainability; continue research to develop and refine the services offered, increase capacity and reduce costs

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 3.1.2	Continue to deliver genotyping services to wheat and barley breeding programs in Australia and internationally	30/06/2007	Yes		Continue to deliver service
Milestone 3.1.3	Continued evaluation and marketing of the system to assist commercialisation	30/06/2007	Yes		Manage the transfer of the CRC's share in the business
Output 3.2	Mutagenesis of wheat – breeding technology				
Milestone 3.2.1	Continuing proof of concept for this non-GMO approach to wheat variety development	30/06/2007	Yes		Project collaboration with ACPFG
Milestone 3.2.2		30/06/2008	No	Milestone not yet due	Explore potential opportunities to make the technology available post-CRC through sale, assignment or some other transfer

Program 4 – Germplasm and Varieties

Outcome – The outcomes from this program will include wheat germplasm, varieties and breeding technologies.

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 4.1	Soft Wheat Program – QAL2000(1); QALBis(1)				
Milestone 4.1.1	Continue to license to AGI	30/06/2007	Yes		Continue to manage licence agreement and relationship with AGI
Milestone 4.1.2	Approximately 22,000 tonnes produced	31/12/2006	Yes		Manage transition of licensing arrangements to organisation continuing with the Soft Wheat Program
Output 4.2	Soft Wheat Program – WW3362; C1064				
Milestone 4.2.1	Initial seed-multiplication of lines	30/06/2007	Yes		Manage process of seed multiplication for commercial seed quantities
Milestone 4.2.2	Negotiation of licence agreements for commercialisation	30/06/2008	No	Milestone not yet due	Manage transition of licensing arrangements to organisation continuing with the Soft Wheat Program
Output 4.3	Waxy Wheat Program				
Milestone 4.3.1	On-going contract research and development program with George Weston Foods	30/06/2007	Yes		Continue to manage research contract and relationship with GWF
Milestone 4.3.2	Continued progress with the program and advancement of lines for commercialisation	30/06/2007	Yes		Continued wheat development program in parallel with quality assessment and product development

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 4.3.3		30/06/2008	No	Milestone not yet due	Manage transition of licensing arrangements to organisation continuing with the Waxy Wheat Program
Output 4.4	Germplasm				
Milestone 4.4.1	Continued development of germplasm incorporating various traits including high molecular weight, sprouting tolerance, null polyphenol oxidase, large grain size, extremes of water absorption pentosans, extremes of starch granule size distribution, high apparent amylose starch, high milling yield and the DM5637*B8 line	31/03/2008	No	Progress is on target for delivery by due date at end March 2008.	Continue to progress these lines to be incorporated in CRC lines for commercialisation and/or licenced to wheat breeding programs in Australia
Milestone 4.4.2	Germplasm transfer agreements in place for DM5637*B8	30/06/2002	Yes		Manage transition of material to organisation(s) willing and able to continue activities
Output 4.5	Doubled Haploid Service				
Milestone 4.5.1	Provide internally to CRC projects and externally on a fee for service basis	30/06/2007	Yes		
Milestone 4.5.2	Market research to determine commercial viability of product	30/06/2007	Yes		Look at opportunities for sustainable fee for service business in line with industry requirements and other service capacity in Australia – manage transition of service if appropriate

The CRC also has an active technology transfer program managed in Program 5. Some of the activities undertaken during 2006-07 include:

- Expanding the Triticarte® database to accommodate an online ordering and sample-tracking system;
- DArT® profiling of primary synthetic CIMMYT wheat lines for the benefit of Australian breeding programs;
- Good progress on contracted development of a user-friendly web-implementation of ICIS, including a module capable of handling high-throughput DArT® data;
- Website and bi-annual meetings to keep breeders informed of data and events.

Commercialisation and Utilisation Activities - Discussion

The decision by the Board during 2006/07 to wind-up or transfer the activities of the CRC at the end of the Commonwealth contract has led to an adjustment of the commercialisation and utilisation strategies. The new aims include maximising the benefits of outcomes and endeavouring to transfer the existing commercial arrangements and activities to keep them going after the CRC. The key activities that may continue after the CRC include the speciality wheat breeding programs, the breeder services (including Triticarte®) and some of the diagnostic products.

Some of the new and improved products and services being commercialised and/or utilised during 2006/07 include:

- QAL3362(ϕ) and QAL1064(ϕ) soft wheat varieties
- Doubled haploid service
- LMA screening service
- Crown rot testing
- Antibody diagnostic tests
- Triticarte® genotyping services

Triticarte Pty Ltd is the sole spin-off company formed by the Value Added Wheat CRC. It is an incorporated joint venture with the Canberra-based organisation Diversity Arrays Technology (DArT®) Pty Ltd. Triticarte® delivers whole genome genotyping services to wheat and barley breeding programs in Australia and overseas. Commercial revenue grew by 20% from 2005/06 and orders continue to increase. The CRC owns 50% of the business and will manage a transfer of its share in 2007/08.

Management of intellectual property (IP) generated in the Centre.

During the reporting year, the most important IP protection issues revolved around the patent family for WheatRite®, the patenting of our method for improving the quality of gluten extracted from wheat and patent applications on two antibodies developed in Program 1. Plant Breeder's Rights (PBR) applications were filed for two new varieties of soft wheat and another triticale variety, and most PBR applications that had been initiated in earlier years were continued (waxy wheat, soft wheat and triticale). The IP portfolio is listed in Table 4.2. We have maintained all older patents, PBR (designated "Φ") and trademarks, with the exceptions noted below.

Following the grant of a United States patent for WheatRite® after an earlier rejection by the US examiner had been successfully opposed (patent number US-07074579), it was decided to proceed with a "divisional" application to cover some claims that had not been re-instated by the examiner, and this was published in February 2007. As well, the Japanese and Canadian patents were progressed. Bayer CropScience is paying for all this WheatRite® patent activity under the terms of the licence agreement with their former subsidiary C-Qentec, which is being novated.

The patenting of our method for improving the quality of gluten extracted from wheat was abandoned and re-filed a second time at the end of 2006 to give further time for negotiations with a new potential licensee - a large multinational company's research and product development group based in Belgium. They had expressed some interest and signed a confidentiality agreement. We ran preliminary tests on their range of products to see whether our process could give them commercial benefits; however, they are a quality-conscious producer of gluten and our process may not benefit producers who are already using higher quality wheat as raw material. Therefore the high-risk strategy of abandoning and re-filing the patent a second time was a justified way of keeping IP costs down given the limited likelihood that the technology will be commercially valuable (illustrated by the multinational's lack of response to our results).

The provisional patent applications that had been filed on the two "GBSS" antibodies developed in Program 1 were abandoned. The high potential cost of the "specific single antibody" approach to protecting our immunology work in Program 1 (targeted at the variety diagnostic) had been causing concern for some time. We had confirmed that NSW DPI would have freedom to operate with the technology that had been developed in the CRC project, if the CRC made a decision to phase out this research. That decision was made following the failure of the CRC's third round application and we therefore abandoned the two provisional specifications. There was clearly insufficient commercial potential in this IP to justify the considerable costs of going to the international (PCT) stage. We also permitted the scientists involved to publish their work.

During the reporting year, the previously adopted general IP management procedures were continued. These are aimed at accruing the maximum national benefits from the CRC's research. The Senior Management Group (SMG) regularly discussed new IP arising in projects, and the Managing Director and Research Director surveyed all the CRC's publications and project reports for IP that could and should be protected. The IP subcommittee, which comprises an expanded SMG membership, meets at roughly annual intervals in the presence of a patent agent, but there was no formal meeting during the year in review as the last one had been in May 2006. The subcommittee ratified and approved the MD's recommendations out of session with expert advice. A summary of actions on IP was included in each MD's Report to the Board (five in the year). An up-to-date IP Register (background and project IP) was maintained. All students and secondees in the CRC had access to IP training. The Managing Director and Research Director both have long experience of the management of IP portfolios; the IP generated in the Value Added Wheat CRC (and that carried forward from Quality Wheat CRC) is therefore managed in accordance with sound commercial strategy and with the National Principles of IP Management.

In the past the CRC has developed a business strategy to ensure that the intellectual property developed from the research being conducted will be used and applied to maximise commercial revenue to the CRC. The cooperative relationships and links with creators and users of the intellectual property, both internally (core partners) and externally - vital to maximise revenue to the CRC – are shown in the research collaborations section of this report. No new technology licenses requiring Commonwealth approval were signed in the reporting year.

The principal commercialisation paths and IP management methods used by the CRC are exemplified here:

Licensing of varieties covered by Plant Breeders' Rights: Specialist Wheat Varieties e.g. QAL2000Φ, QALBisΦ and Waxy wheat (outcomes from Program 4).

Licence agreements on proprietary biological material: Wheat Germplasm e.g. sprout tolerant germplasm (Program 4 and QWCRC).

Commercialisation of a service based on a patented method and proprietary biological material: Molecular Marker Services e.g. Triticarte® (Program 3 outcome).

Licence agreement on patented immunological reagents: Quality Diagnostics e.g. WheatRite®/ReadRite® (outcomes from Programs 1 and 3).

Direct evaluation of technology in participant's laboratory: Methods for Variety Identification (outcome from Program 1).

Direct installation of proprietary (sometimes patented) technology in Participants' factories: Process Improvements e.g. Optidough™ and gluten manufacturing improvements (Program 2 outcomes).

Distribution of copyrighted material: Publications and designs e.g. "Quick Guide to Genetics…" (Program 5 outcome) and the mini Z-arm mixer equipment (QWCRC outcome).

Table 4.2: Intellectual Property Portfolio

VAWCRC Patent Applications

Country	Filing Date	Application No	Title	Status
Australia	11.11.99	757926	Detection of pre-harvest sprouting in cereal grains	Registered
Canada	11.11.99	2345403	Detection of pre-harvest sprouting in cereal grains	Under examination
Europe	11.11.99	1137935	Detection of pre-harvest sprouting in cereal grains	Registered
France	11.11.99	1137935	Detection of pre-harvest sprouting in cereal grains	Registered
Germany	11.11.99	69917481	Detection of pre-harvest sprouting in cereal grains	Registered
Italy	11.11.99	29383BE/2004	Detection of pre-harvest sprouting in cereal grains	Registered
Japan	11.11.99	2002-581446	Detection of pre-harvest sprouting in cereal grains	Under examination
UK	11.11.99	1137935	Detection of pre-harvest sprouting in cereal grains	Registered
USA	11.11.99	7074579	Detection of pre-harvest sprouting in cereal grains	Registered
USA	1.06.06	11/421712	Detection of pre-harvest sprouting in cereal grainns (Divisional of US Patent No. 7074579)	Under examination

VAWCRC Provisional Patent Applications

Country	Filing Date	Official Number	Title	Status
Australia	7.11.05	2005906156	Novel method for treating flour or a fraction thereof	Filed

VAWCRC Trade Mark Applications

Country	Filing Date	Application No	Title	Status
Australia	24.08.98	771211	WHEATRITE in Class 1	Registered
Canada	05.02.99	533941	WHEATRITE in Class 1	Registered
European	03.02.99	1063858	WHEATRITE in Class 1	Registered
USA	10.02.99	2338037	WHEATRITE in Class 1	Registered
Australia	01.09.00	848572	READRITE in Class 9	Registered
Canada	10.11.00	601811	READRITE in Class 9	Registered
USA	11.12.00	2655684	READRITE in Class 9	Registered

VAWCRC Plant Breeders Rights Applications (PBR)

Country	Variety	Application No	Date Accepted	Status
Australia	QAL2000(ф)	2001/304	3 December 2001	Granted Certificate No. 2268
Australia	QALBis(ф)	2002/181	12 September 2002	Granted Certificate No. 2744
Australia	*VAW51(ф)	2004/253	23 December 2004	Accepted
Australia	*VAW59(ф)	2004/254	23 December 2004	Accepted
Australia	*VAW64(ф)	2004/255	23 December 2004	Accepted
Australia	QAL1064(ф)	2006/291	15 December 2006	Accepted
Australia	QAL3362(ф)	2006/292	26 December 2006	Accepted
Australia	**Breakwell(ф) Triticale	2005/342	22 February 2006	Accepted

* These PBR applications have been jointly submitted by the VAWCRC and George Weston Foods Ltd.
**This PBR application has been jointly submitted by the VAWCRC and GRDC.

Triticarte Trade Marks

Country	Filing Date	Certificate No	Title	Status
Australia	26.05.05	1019425	Triticarte	Granted
Australia	26.05.05	1019429	Triticarte (logo)	Granted

COMMUNICATION STRATEGY AND END USER INVOLVEMENT

Communication Strategy

VAWCRC has a communication strategy to deliver information on our activities, outputs and achievements at various levels. It is aimed to give the relevant parties – the Commonwealth, Core Partners, Supporting Participants, the Industry and the world in general – the right amount and detail of information without breaching confidentiality or other contractual requirements. The communication activities used by the CRC include:

1 Web page: Provides general information on the operation, structure and activities of the CRC.

2 Annual report: Reviews the annual operation of the CRC and highlights achievements. This document targets the Commonwealth, shareholders of the CRC and the industry in general.

3 Corporate brochure: Developed for distribution to promote the activities and achievements of the Centre to the industry.

4 Wheat CRC newsletter: Produced and distributed at regular intervals to detail and highlight current research and commercialisation activities in the Centre. This document is targeted at industry and distributed widely to our comprehensive contact database.

5 Press releases: Developed for general and rural press distribution. These releases detail important developments and achievements in the CRC.

6 Development of links with SMEs: A hands-on approach is taken to involve SMEs in our research, commercialisation and technology transfer activities, as described under End-User Involvement in the Commercialisation section of this report. Six SMEs participate in our research program and eight in use and commercialisation of our technology. Tables R6, 4.3 and 5 attest to the success of this approach.

7 Conferences, workshops, seminars, industry consultation forums: These provide opportunities for technology transfer activities of the CRC. The CRC also sponsors forums to assist in their planning and execution and to allow for other organisations to attend and present their technology in addition to the dissemination of VAWCRC information.

8 Publications: These include project reports, scientific and educational publications.

9 Mail and email communication: Directly targets participant and customer organisations, keeping them updated on Centre activities.

10 Board and Senior Management Group meetings and quarterly report database: The meetings provide direct communication between senior managers in Core Partner organisations with updates on progress with the work and outcomes of the CRC.

End-User Involvement and CRC Impact on End-Users

The successful adoption of technology and outputs from the CRC's activities is dependent on the linkages and relationships with the technology users. The CRC interacts with a range of organisations that are end-users of the research outcomes. They include Core and Supporting Participants, other research organisations, large organisations and SMEs of various sizes, linked via license arrangements, project involvement or customer interactions. Through these interactions each of the end-users will solve a problem, or obtain a benefit or competitive advantage that assists them in achieving their operational objectives. The following table contains details of the end-users, the basis of the interactions and the nature of the benefits they obtain from their relationships with the CRC.

Table 4.3: SMEs Involved in Research, Commercialisation and Technology Transfer Activities

All Wheat and barley breeding programs in Australia - AGT - EGA - Longreach Plant Breeders Austgrains International Australian Centre for Plant Functional Genomics Byron Australia	Cereal Solutions CRC for Molecular Plant Breeding DArT Pty Ltd Newport Scientific Penford Australia Triticarte Pty Ltd Waratah Seeds

Table 5: End-user Involvement in CRC Activities

End-user name	Relationship with CRC	Type of activity and end-user location	Nature / scale of benefits to end-user	Actual or expected benefit to end-user ($ terms)
Arnott's Biscuits	Core Partner	Biscuit manufacturer. Factories in NSW, Qld and SA.	• Pipeline of soft wheat varieties for use in biscuit manufacture. • Knowledge of shelf-life of baked goods held in modified atmosphere packaging.	• Continuity of supply of soft wheat lines to spread risk of supply. • Flour for use in biscuits (20% of Northern grist). • Cost savings. • Potential new products.
Allied Mills	Core Partner	Flour Miller. Mills throughout Australia.	• Pipeline for soft wheat varieties for use in mills. • Access to and evaluation of predictive wheat variety/quality technology.	• Continuity of supply of soft wheats. • Ability to build customer relationships based on access to soft wheats. • Segregation of wheat for functionality earlier in supply chain. • Savings in storage & handling costs.
Bayer CropScience	Core Partner	Agricultural diagnostics company. Headquarters in Sydney.	• Patent, Trade Mark and know how. Licence for WheatRite® and ReadRite® testing system. • Access to diagnostic intellectual property developed in the CRC.	• Products for commercial sale. • Sales expected to be $2-3m by 2010.
George Weston Foods	Supporting Participant and Licensee	Flour miller and food company. Australia-wide organisation - Headquarters in Sydney.	• Exclusive access to produce waxy wheat varieties developed in the CRC.	• Milling of waxy wheats. • Selling of waxy flour. • Improved traditional wheat-based foods with higher value (confidential). • New products for industry.
Byron Australia*	Licensee	Food research company. Based in Sydney.	• Access to waxy wheat for R&D and product development.	• Ability to sub-licence technology for use of flour and whole grains by customers. • New products for industry.
AustGrains International*	Licensee	Seed and grain company. Based in Moree, NSW.	• Exclusive license to commercialise CRC soft wheat varieties QAL2000(ᵇ), QALBis(ᵇ) and later lines.	• Wheat varieties to commercialise. • Ability to generate income from seed sales and contracting of grain.
Waratah Seeds*	Supporting Participant and Licensee	Seed company. Majority of members based in southern NSW.	• Licenses to commercialise triticale varieties and a soft wheat.	• Triticale varieties to commercialise. • Ability to generate income from seed sales.
Wheat Research and Breeding Organisations*	Core Partners, Supporting Participants, Customers	Wheat research and breeding organisations including private companies, Departments of Agriculture, AWB, universities, CRCs, ACPFG - Australia-wide (and internationally).	• Ability to access advanced germplasm and technology: • Synthetic, mutated and other enhanced quality wheat germplasm, • Triticarte® genotyping service, • Doubled haploid service, LMA services, breeder antibody test kits.	• Improved ability to conduct research. • Increased speed and efficiency of wheat variety development. • Access to unique breeding support services.
Newport Scientific*	Licensee	Instrument manufacturer. Based in Sydney.	• Licence Agreement to manufacture, market and distribute Z-arm mixer.	• New product and instrument for the industry. • Add to product range and income of the organisation.

*Asterisk denotes SME

PROGRAM 5: EDUCATION AND TECHNOLOGY ADOPTION

Program Manager: Ms Clare Johnson

The educational focus is widely dispersed throughout the Centre, with PhD training included in securely funded projects in all Programs. We have achieved our target of supporting at least 30 postgraduates with industry exposure within the term of the CRC. A postgraduate initiative to address an urgent succession issue was concluded this year, having produced five new wheat breeders for the industry. Additional training in project and people management, presentation skills, intellectual property, commercialisation and occupational health and safety has been provided to all students, to enhance their value as future team leaders in the industry.

A number of technical workshops, relevant to wheat industry issues, are run each year to provide for the continuing education of researchers and to foster innovative approaches. These involve both internal and external experts. We are using product and IT development initiatives and workshops to assure the rapid adoption of advances in breeding technology, diagnostics and processing, as they become available. Practical manuals are created for researchers' future use and for integration into tertiary courses.

The GRDC grant for coordination and knowledge management relating to nationwide trials of CIMMYT wheat lines in Australia is providing an outstanding opportunity for initiatives in technology transfer.

Program Aims

Our aims in this program are:

- to generate a succession of tertiary educated and postgraduate scientists and technicians, with practical experience of wheat quality science, plant breeding, analytical and business skills
- to achieve effective technology transfer of outcomes of VAWCRC research programs through product and IT development initiatives, publications, workshops, and development and revision of nationally accredited courses
- to provide information on current developments to researchers, industry and consumers through targeted workshops.

Project No: 5.1.1

Project Title: Skilled Graduates and Postgraduates for Industry Succession

Project Leader: Ms Clare Johnson

Background and Objectives

The VAWCRC has aimed to support at least thirty postgraduate students during the life of the CRC, six in industry. The students have received training in management of intellectual property, projects and people, and safety and information skills, as well as research training co-supervised by academic and industry personnel. Vacation scholarships and undergraduate scholarships are provided to attract talented students to the industry. A program of technical workshops is offered for research staff and students, run jointly with other institutions where appropriate. Manuals from these workshops are being utilised in the Graduate Certificate in Cereal Science developed in Project 5.1.2.

Progress

As part of our initiative to address an urgent succession issue in plant breeding (see also project 5.3.6), a further 4th year undergraduate scholarship in plant breeding, and a summer scholarship, were awarded at the University of Sydney, both students pursuing excellent projects (Table E1). Our undergraduate scholar sponsored at Sydney University has completed her degree and has taken up employment in the industry prior to postgraduate study.

Four technical workshops were run successfully, featuring 7 members of our diagnostics team from project 1.1.2 based at DPI NSW, in addition to international guest speakers in collaboration with the RACI - Cereal Chemistry Division (Table E2). We also ran two interactive forums with plant breeders and participated in two high-level reviews related to technology transfer and Plant Breeder's Rights. A further three workshops are planned early in 2007-2008.

The postgraduate students in the VAWCRC are detailed in Table E3. Their fields of study range from plant breeding, biotechnology and computational science to industrial biochemistry, food science and nutrition. All students are either directly co-supervised by industry participants or are exposed regularly to industry by positioning their projects as part of a larger industry initiative. Four of our students submitted their theses and seven are currently writing up. Most will graduate from the University of Sydney, one from RMIT University and one from Curtin University.

All students have received intensive training in project management, IP and commercialisation and routinely receive ongoing training in project management via quarterly reporting

against academic and technical milestones. The additional targeted training allowance was used by individual students for workshops in statistics, population genetic analysis and experimental design for plant breeding, as well as conference attendance relevant to their disparate specialisations.

Table E1: Undergraduate and Honours Scholarships

Summer scholarship 2006-2007		
Project	**Location**	**Student**
Finding the QTL responsible for the Low Phytic Acid Phenotype in *Triticum aestivum* (Vulcan x Kewell population)	University of Sydney Plant Breeding Institute, Cobbitty NSW	A third year student in Biotechnology, University of Wollongong
Full Undergraduate Scholarship 2003-2006	University of Sydney	Student enrolled in BScAgric.
Honours Scholarships in Plant Breeding 2006		
4th Year Project: Molecular marker study of chromosomal inheritance in DH progeny of the interspecific cross *Brassica napus x B. carinata*	University of WA	A 4th year University of Western Australia BSc (horticulture) student.
4th Year Project: Genetics of *Hordeum bulbosum*-derived rust resistance in cultivated barley	University of Sydney	A 4th year University of Sydney BscAgric student

Table E2: Short Courses and Workshops

Short course / workshop	**Presenters**	**Conference/ location**	**Date**	**Attendees**
CIMMYT User Group (project 5.5.8)	Coordinated by Clare Johnson (VAWCRC)	DPI Vic, Horsham	7 Sept 2006	42
Understanding Appearance, Texture and Quality of Wheat-based Products/ Trained Panels in Sensory Analysis (sponsored)	Coordinated by Vicky Solah (Curtin). Presenters included Hannah Williams (Curtin), Larisa Cato (AWB) and Graham Crosbie (DAFWA)	56th Australian Cereal Chemistry Conference, Fremantle WA	8-9 Sept 2006	18
Antibodies in the Service of the Cereal Chemist and Breeder	Peter Schofield, James Chin, Thomas Giersch, Ming-Jie Wu and Louise Duncan (NSW DPI-EMAI) and Angela Dennett, Neil Howes and Xiaochun Zhao (University of Sydney)	56th Australian Cereal Chemistry Conference, Fremantle WA	13 Sept 2006	87
Colour Measurement and Colour Theory / Defining Product Quality (sponsored)	Tony Blakeney (Cereal Solutions), Nick Harkness (Nick Harkness Pty Ltd), with Stanley Cauvain and Linda Young, BakeTran (UK).	56th Australian Cereal Chemistry Conference, Fremantle WA	15-16 Sept 2006	18
Masterclass in Plant Population Breeding	Prof Duane Falk, University of Guelph; Assoc. Prof. Wallace Cowling, University of WA, Dr Andrzej Kilian, DArT P/L.	University of Sydney Plant Breeding Institute, Cobbitty NSW	21-22 Oct 2006	29
CIMMYT User Group (project 5.5.8)	Coordinated by Clare Johnson (VAWCRC)	Plant Breeding Centre, University of Adelaide, Waite Campus	2 Mar 2007	52
Participation in high-level reviews				
ICIS Developers' Workshop	Sandra Micallef, Ian DeLacy, Vivi Arief (UQ), Rowena Valerio, Thomas Metz, Graham McLaren (IRRI), Grzegorz Uszynski (Triticarte), Dave Edwards (ACPFG), Clare Johnson (VAWCRC)	University of Queensland	19-23 Mar 2007	9
ACIP Review of Enforcement of Plant Breeders' Rights	Clare Johnson, Peter Vaughan, Ian Batey, Colin Wrigley (VAWCRC)	Australian Centre for Intellectual Property	5 June 2007	4
Planned workshops				
Statistics for Plant Breeding and QTL Analysis (sponsored)	Brian Cullis (NSW DPI), David Butler (QDPI&F), Ari Verbyla (University of Adelaide), coordinated by Colin Cavanagh (CSIRO)	CSIRO Corporate Headquarters, Canberra ACT	23-26 July 2007	43

Short Course / Workshop	Presenters	Conference/ Location	Date	Attendees
Test Baking	Coordinated by Joe Panozzo and Phil Downie, RACI-CCD.	57th Australian Cereal Chemistry Conference, Melbourne, Vic	10-11 Aug 2007	Est. 30
CIMMYT User Group (project 5.5.8)	Coordinated by Clare Johnson (VAWCRC)	University of Sydney Plant Breeding Institute, Cobbitty NSW	17 Sept 2007	Est. 65
Statistics for Plant Breeding and QTL Analysis (sponsored)	Brian Cullis (NSW DPI), David Butler (QDPI&F), Ari Verbyla (University of Adelaide), coordinator TBA	Plant Breeding Centre, University of Adelaide, Waite Campus (TBC)	Date TBA 2007	TBA
CIMMYT User Group (project 5.5.8)	Coordinated by Clare Johnson (VAWCRC)	Plant Breeding Centre, University of Adelaide, Waite Campus	Mar 2008	Est. 65
CRCA Conference integrated workshops	Paul Hopkins (Vision CRC), Mingan Choct (Poultry CRC), Clare Johnson (Value Added Wheat CRC), Chris Day (Poultry CRC), Geoff Allen (Beef CRC), David Lind and Kathy Rod (Grainfoods CRC)	Environmental Biotechnology CRC, Australian Technology Park, Eveleigh, Sydney	May 2008	TBA

Table E3: Postgraduate Students of VAWCRC *(** industry-based students indicated in **bold** type)*

Student	Degree	Location	University	Thesis Title	Date Started	Supervisors/ Organisations	Funding Source	Subsequent Employment
Mohammad Hassani	PhD	USyd Plant Breeding Institute, Cobbitty	Sydney	Novel storage protein	Mar-00	Dr Peter Sharp, University of Sydney	QWCRC/ VAWCRC	University of Sydney Plant Breeding Institute
Araluen Freeman	PhD	NSW DPI – EMAI, Menangle NSW	Sydney	Diagnostics for wheat varietal identification	Jan-02	Dr. James Chin, DPI NSW-EMAI, Prof. Cris dos Remedios, University of Sydney	VAWCRC	Biomedical research, UNSW
Karon Ryan	PhD	Murdoch University	Murdoch	Validation of molecular markers in wheat for the quality traits of flour colour and grain size	Jan-02	Dr Michael Francki Dept. Agric. WA Prof Rudi Appels Murdoch University /Dept. Agric. WA Prof Mike Jones WA State Agric. Biotech. Centre,Murdoch Univ.	VAWCRC	Research, Murdoch University
Yunxian Mak	PhD	Australian Proteome Facility, Macquarie University campus	Sydney	A proteomic approach to the investigation and characterization of wheat protein	Feb-02	Prof. Les Copeland, University of Sydney Prof. Peter Sharp, Plant Breeding Institute, University of Sydney	VAWCRC	Proteome Research Officer in ovarian cancer research, Prince Henry's Institute, Monash University
Michelle Powell	MSc	NSW DPI – EMAI, Menangle NSW	Sydney	Characterisation of polymorphic proteins for variety and quality traits	Feb-02	Dr. James Chin, DPI NSW-EMAI; Dr Elizabeth Hegedus University of Sydney	VAWCRC	Not industry

Student	Degree	Location	University	Thesis title	Date Started	Supervisors/ Organisations	Funding Source	Subsequent Employment
Cindy Soh	PhD	NSW DPI – Tamworth Centre for Crop Improvement	Sydney	Influence of protein composition and non-starch polysaccharides on pasta quality using semolina reconstitution	May-02	Dr. Mike Sissons, NSW DPI (Tamworth) Dr Matthew Turner, University of Sydney	VAWCRC	Lecturer, Nanyang Polytechnic, Singapore
Anneliese Rittau	PhD	Allied Mills, Summer Hill, Sydney	Sydney	Development of a screening test for wheat protein quality	Jan-03	Dr Ian Batey & Dr Colin Wrigley, CSIRO - Food Science Australia, Ms Di Miskelly, Allied Mills, Prof. Les Copeland, University of Sydney	VAWCRC	Research Assistant, University of Sydney Pharmacy Dept, seeking postdoc.
Mary (Chiming) Tang	PhD	University of Sydney (Agricultural Chemistry)	Sydney	Analysis of starch-lipid complexes	Mar-03	Prof. Les Copeland, University of Sydney	VAWCRC	Thesis to be submitted shortly, seeking postdoc.
Brent Thomson	PhD	Diversity Arrays Technology Pty Ltd, Canberra	Sydney	DArT® microarrays for wheat	Mar-03	Dr Andrzej Kilian, DArT P/L Prof. Peter Sharp, University of Sydney	VAWCRC	Technical Applications Specialist, Genesearch
Wendy Newton	PhD	Curtin University (Dept Nutrition)	Curtin	Novel process for novel products	Jan-04	Ms Vicky Solah, Curtin University, Ms Cathy Fryirs, Weston's Technologies	50:50 VAWCRC / Westons FIG	current
Peter Schofield	MSc	NSW DPI – EMAI, Menangle NSW	Sydney	Antibody-based diagnostics	Feb-04	Dr James Chin, DPI NSW-EMAI, Dr Neil Howes, University of Sydney	VAWCRC	Proceeded to PhD study in wheat industry
Thu Vu	PhD	Food Science Australia, Werribee	RMIT	Protein-lipid and protein-protein interactions in gluten	Feb-04	Dr Li Day, CSIRO Food Science Australia, Werribee, Dr Daryl Small, RMIT University	VAWCRC	R&D Scientist, CSIRO Food Science Australia, Werribee
Jessica Dalton-Morgan	PhD	USyd Plant Breeding Institute, Cobbitty	Sydney	Targeted mutagenesis technology for wheat	Feb-04	Dr Chong-Mei Dong, University of Sydney	VAWCRC	current
Abdus Sadeque	PhD	USyd Plant Breeding Institute, Cobbitty	Sydney	Genetics of polyphenol oxidase activity in wheat and evaluation of the efficiency of introgression of null PPO and disease resistance into soft and hard wheats	Feb-04	Dr Matthew Turner and Dr Akram Khan, University of Sydney.	VAWCRC	Thesis in advanced stage, seeking postdoc.
Shahanara Begum	PhD	USyd Plant Breeding Institute, Cobbitty	Sydney	Efficient breeding and QTL mapping for wheat quality improvement.	Feb-04	Dr Matthew Turner, Dr Neil Howes, University of Sydney	VAWCRC	current

EDUCATION & TECHNOLOGY ADOPTION - PROGRAM 5

Student	Degree	Location	University	Thesis Title	Date Started	Supervisors/ Organisations	Funding Source	Subsequent Employment
Doris Mercado-Escueta	MSc	USyd Plant Breeding Institute, Cobbitty	Sydney	Effects of sprouting tolerance and rust resistance genes on agronomy and grain quality	Apr-04	Dr Matthew Turner, Dr Neil Howes, University of Sydney	VAWCRC	Quarantine Officer, Dept Agriculture, Fisheries and Forestry - Australian Quarantine and Inspection Service (AQIS)
Ming Wu	PhD	NSW DPI – EMAI, Menangle NSW	Sydney	Proteomic and immunological characterisation of polymorphic grain proteins in wheat for varietal differentiation	May-04	Dr James Chin, DPI NSW-EMAI	VAWCRC	Research Scientist, NSW DPI - EMAI
Hayfa Salman	PhD	University of Sydney (Agricultural Chemistry)	Sydney	Influence of starch-lipid complexes on nutritional components of wheat during storage	Jul-04	Prof. Les Copeland, University of Sydney	VAWCRC	current
Lynn Madden	PhD	AGT, Narrabri	Sydney	QTLs for yield and grain size in AGT's breeding program	Jul-04	Dr Meiqin Lu, AGT, Dr Neil Howes, University of Sydney	50:50 VAWCRC / AGT	Operations Manager, Australian Grain Technologies, Narrabri
Omid Ansari	PhD	USyd Plant Breeding Institute, Cobbitty	Sydney	Breeding and evaluating hard and soft wheats with high amylose starch.	Sept-04	Dr Neil Howes, University of Sydney	VAWCRC	To submit early July prior to taking up Posdoctoral Fellowship in plant breeding at University of Saskatchewan
Samar Shenouda	PhD	USyd Plant Breeding Institute, Cobbitty	Sydney	Development and characterization of diagnostic monoclonal antibodies against key wheat quality-related targets	Dec-04	Dr James Chin, DPI NSW-EMAI.	VAWCRC	current
Tuyen Vu	MSc	NSW DPI – EMAI, Menangle NSW	Sydney	Antibody diagnostics for key wheat quality targets	Jan-05	Dr James Chin, DPI NSW-EMAI.	VAWCRC	Proceeded to PhD study in wheat industry
Stephen McKay	MSc	NSW DPI – EMAI, Menangle NSW	Sydney	Development of diagnostic platform 2 for wheat cultivar identification	Feb-05	Dr James Chin, DPI NSW-EMAI.; Dr Neil Howes, University of Sydney	VAWCRC	current
Alex Eng	PhD	NSW DPI – EMAI, Menangle NSW and USyd Nutrition	Sydney	Studies on wheat grain amylose and glycaemic index	Mar-05	Dr James Chin, DPI NSW-EMAI; Prof. Cris dos Remedios, University of Sydney	VAWCRC	current
Clare Johnson	MBT	VAWCRC, North Ryde	UNSW	Coursework Master of Business and Technology	July-05	N/A	VAWCRC	current

Student	Degree	Location	University	Thesis title	Date Started	Supervisors/ Organisations	Funding Source	Subsequent Employment
Jaroslav Blazek	PhD	University of Sydney (Agricultural Chemistry)	Sydney	Varietal influences on formation and properties of wheat starch-lipid complexes	Aug-05	Prof. Les Copeland and Dr Neil Howes, University of Sydney	VAWCRC	current
Sameer Tiwarii	PhD	NSW DPI – Tamworth Centre for Crop Improvement	Sydney	Identification of molecular markers for blackpoint and characterisation of associated biochemistry	Nov-05	Dr Mike Sissons, DPI NSW, Dr Matthew Turner, University of Sydney	VAWCRC	Withdrew for personal reasons
Andrew Kennett	Grad Cert	Arnott's Biscuits Ltd	UWS	Coursework Graduate Certificate in Quantitative Methods	Mar-06	N/A	VAWCRC	current
Peter Schofield	PhD	NSW DPI – EMAI, Menangle NSW	Sydney	Antibody-based diagnostics	Mar-06	Dr James Chin, DPI NSW-EMAI	VAWCRC	current
Tuyen Vu	PhD	NSW DPI – EMAI, Menangle NSW	Sydney	Antibody-based diagnostics	Mar-06	Dr James Chin, DPI NSW-EMAI	VAWCRC	current
Natalie May	PhD	Allied Mills, Summer Hill, Sydney	Sydney	Improved downstream processing using different genotypes and ingredients	Mar-06	Prof. Les Copeland, University of Sydney, Di Miskelly, Allied Mills, Dr Ian Batey, Food Science Australia	VAWCRC	current

Project No: 5.1.2

Project Title: Initiatives for Uptake of VAWCRC Innovation

Project Leader: Ms Clare Johnson

Background and Objectives

Technology transfer of outputs from the research programs of the Wheat CRC is achieved via liaison and communication with relevant industry sectors, and provision of accredited courses, software and publications for their staff and for consumers. Our methods include workshops with industry, to promote innovative use of the research outcomes and to assess industry priorities for further research. There is an increasing focus on innovative technology for breeders arising from Programs 1 and 3, in particular through this project's contribution to Triticarte IT and diagnostic platform development. We also support relevant industry conferences and courses.

Progress

The database for management of Triticarte® data has been expanded to accommodate an on-line ordering and sample tracking system. Leveraging off publicly available phenotyping data from GRDC's Australian Winter Cereals Molecular Marker Program, 180 primary synthetic hexaploid wheats from CIMMYT were subjected to exploratory DArT® using over 20,000 markers. This has helped to expand the diversity available in the consolidated v2.5 wheat DArT® chip, and will add to the informativeness of the markers to predict in wheats derived from this germplasm characters such as LMA and other traits already phenotyped in the primary synthetics, at finer resolution. The book on Population Plant Breeding is progressing well and the Graduate Certificate in Cereal Science continues to run at Charles Sturt University. We sponsored the RACI-Cereal Chemistry Division 2007 conference and workshop, and have regularly updated the websites of VAWCRC and Triticarte Pty Ltd.

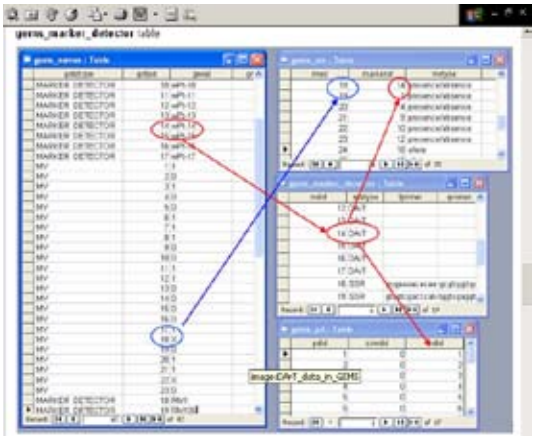

Figure 5.1: Discussion thread on development of the DArT® module, in ICIS-Wiki.

Project No: 5.3.5

Project Title: **Novel Process for Novel Products**

Project Leader: **Ms Vicky Solah**

Background and Objectives

This PhD project at Curtin University of Technology has been 50% supported by George Weston Technologies through funding from the National Food Industry Strategy Food Innovation Grant. The focus of the project is to explore potential applications of waxy wheat in novel products, using novel processes. The information generated through analysis of the mechanisms applied, and the results obtained, will provide valuable insight into contributing and interacting factors. Additionally, the relationship between specific process performance and starch properties will be examined to assess whether performance can be predicted. The nutritional implications will be examined.

Progress

The research has focused on process manipulation for waxy wheat, especially the triple nulls (Goldmark and NP150T). A range of variables has been explored: extrusion variables (temperature, pressure, dry feed rate, liquid feed rate), cooking techniques, water activity, Rapid ViscoAnalyser parameters, and flour swelling properties. Research is being undertaken to determine changes in starch crystal structure and the nature of the formation of resistant starch due to the processes. These processes and data collected will be used to try to understand the underlying structure of waxy wheat. Double null, single null varieties and waxy rice have been included in all stages of processing for comparison. The effect of protein will also be studied as Goldmark has much stronger protein than NP150T.

Project No: 5.3.6

Project Title: **PhDs by Research, in Plant Breeding**

Project Leaders: **Dr Akram Khan, Dr Matthew Turner**

Background and Objectives

VAWCRC's 2004 initiative to address Australia's impending shortage of wheat breeders by offering undergraduate scholarships (project 5.1.1) and postgraduate scholarships (projects 2.4.13, 4.3.8, 5.3.6 and 5.4.7), was enhanced by provision of workshops in the Agrobase and MapManager programs, Population Plant Breeding and statistics for QTL Analysis in Plant Breeding (to be run in early July 2007), and by provision of travel grants for international study trips. The students have gained a solid grounding in field breeding and modern technologies, including Triticarte® high-throughput profiling. The PhD projects were designed to deliver improved cultivars that address current Australian wheat industry issues.

Progress

PhD student Shahanara Begum conducted linkage grouping using the Carte Blanche program, then regression analysis of marker loci and pentosan phenotypic data from 88 selected Goldmark x DM5637*B8 doubled haploid lines using MapQTL5 and Map Manager (Version 20) (with similar outcomes), and detected putative QTL for soluble pentosans on chromosomes 1A and 2B, and additional QTL for pentosan on chromosomes 3A, 3B, 6B and 7B. In 180 DH lines phenotyped for sprouting tolerance by the germination test, she detected putative QTL for sprouting tolerance on chromosomes 1D and 7B. Final milling and quality testing are underway and the thesis chapters are being drafted.

Having completed her experimental work characterising rust resistance genes in a soft wheat breeding population, Masters student Doris Mercado-Escueta completed in September 2006 and submitted her Masters thesis.

Project No: 5.4.7

Project Title: **QTL for Yield, Grain Size, Milling Yield and Noodle Colour in the Breeding Program of Australian Grain Technologies (AGT)**

Project Leaders: **Dr Neil Howes, Dr Meiqin Lu**

Background and Objectives

Part time PhD student Lynn Madden based at Narrabri, NSW, is working to identify QTL that are important to the breeding program of Australian Grain Technologies Ltd (AGT) and to develop a way in which QTL information can be used to make selection decisions in a breeding program where populations may be small. A range of growing environments is being used to determine whether QTL are stable across the varying conditions. The QTL of interest are for yield, grain size, milling yield and noodle colour. AGT has contracted to provide funding until 2010 to support completion of Lynn's PhD.

Progress

Having completed the map for the Wedgetail x Ellison population, reliable yield and quality data were gathered in 2006 (Table R7). This will be combined with data from 2005 and then applied to the map to identify QTL. Rust, maturity and disease data were also collected at Narrabri in 2007.

During 2006, the 91 lines of the Wedgetail x Ellison population

were trialled in six sites across NSW. Quality tests on these lines are currently being carried out for 2 of the six sites (Narrabri and Burren Junction). An additional 140 lines now in increase in Narrabri will be DArT®-profiled. Those found to have potential QTL for yield, milling yield and grain size will be added to yield trials with the original 91 lines in 2008, and further phenotyping will be undertaken, to further evaluate the potential QTL.

Table R7: Multi-site trial yield data for the Wedgetail x Ellison population in 2006

Site Name	Lowest Yield	Highest Yield	Average Yield
North Starr	1063	3591	2367
Burren Junction	1892	4131	3080
Moree	2239	6478	3683
Narrabri	1424	4173	2773
Biniguy	1640	3465	2605

Project No: 5.5.8

Project Title: CIMMYT-Australian Coordination and Communication

Project Leaders: Ms Clare Johnson; Dr Richard Trethowan

Background and Objectives

GRDC has funded 8 projects in its CIMMYT suite (Table E4). The aim of the Coordination Project, contracted to VAWCRC, is to achieve more rapid and widespread uptake of CIMMYT wheat germplasm into Australian breeding programs through effective coordination, strategic analysis of genetic resources related to phenotype, and effective communication of results to Australian breeders from all interested organisations. Australian breeder engagement and 'ownership' in evaluation of CIMMYT germplasm for Australia is further encouraged by the project's support for breeder visits to CIMMYT and two breeder consultation forums annually.

Progress

Breeders received regular updates, via email and the project website, on seed increase trials, database development and seed imports from the regular nurseries and the 1,035 selections by Australian breeders in 2006. DArT® profiling of the International Adaptation Trial 2005 (94 lines) was funded to enable correlation with geographic performance data, and selected lines from 2004, 2005 and 2006 were submitted for LMA (459 lines) and yellow leaf spot testing, with rust testing carried out by the Australian Cereal Rust Control Program. We assisted CIMMYT in migrating data from its internal database, IWIS, to ICIS (the open-source International Crop Information System). The informatics unit at IRRI (Philippines) has made good progress on contracted development of a user-friendly web-implementation of ICIS, including a module capable of handling high-throughput DArT® data, in cooperation with the UQ team.

Two CIMMYT User Group interactive forums were held in Horsham on 7 September 2006 (42 attendees) and in Adelaide on 2 March 2007 (52 attendees, including 4 key CIMMYT personnel via a voIP videoconference link to two sites in Mexico). We coordinated delivery of seed from the 2005-2006 imports to over 15 recipients in 9 organisations for trialling, and receipt of trial data from the 2004 imports from 12 breeders. Four wheat breeders were sponsored to visit CIMMYT this year, where they identified a further ~500 lines of potential interest to import for trial in Australia (Table E5).

Because this project explicitly involves importation of wheat lines from an international centre, strong effort went into informing breeders of their new obligations under the 1 January 2007 standard Material Transfer Agreement associated with the International Treaty for Plant Genetic Resources for Food and Agriculture. This included a submission made to the Australian Government's review of enforcement of Plant Breeder's Rights.

Table E4: Projects in GRDC's CIMMYT suite

GRDC- funded project	Contracted to
Quarantine	DPI NSW
Coordination and Knowledge Management	VAWCRC
Synthetics Evaluation	DPI Vic
Germplasm Evaluation	Agrisearch P/L
International Adaptation Trials (IAT)	CSIRO
International Root Disease Resistant Nursery	CIMMYT
Database Development	University of Queensland

Table E5: Breeders sponsored to visit CIMMYT, Cuidad Obregon, Mexico, in March 2007

Phillip Banks	QDPI&F
Haydn Kuchel	AGT
Chris Moore	DAFWA
Richard Trethowan (guide)	University of Sydney

Figure 5.2: Seed increase of CIMMYT lines for distribution to Australian wheat breeding organisations

EDUCATION & TECHNOLOGY ADOPTION - PROGRAM 5

Major Achievements and Outcomes for Program 5 in 2006-2007

- High quality targeted technical training for students and workshops attended by over 250 registrants.
- Strong focus on breeder training and increasingly successful technology transfer initiatives.
- A knowledge management initiative to assist development and uptake of DArT® profiling in wheat.
- Sustainability and marketing analyses of Triticarte P/L and participation in review of Plant Breeder's Rights.

Table 6: Education and Training Outputs and/or Milestones

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Output 5.1/ Milestone 1	30 PhD students qualified for industry during the life of the CRC, with training in IP, QA, safety, project and people management and information skills and relevant technical conferences.	30/06/2008	No, but total is 29 PhD and Masters students (6 in industry) and one Graduate Certificate student.	Withdrawal by an early-stage PhD student in 2006 for personal reasons.	Sponsoring one student in a P/T Graduate Certificate in quantitative methods. The student is a high-level operations manager able to apply the techniques in industry.
Output 5.2	Annual relevant technical workshops	30/06/2008	Yes. Six workshops 2006-2007.		Up to six planned 2007-2008
Output 5.3	Software/ decision support systems and publications for retail.	30/06/3008	Yes, 13 texts for retail; 3 texts incorporating research outcomes in use in postgraduate courses at 2 universities.		Ongoing as new publications arise. Web-based decision support systems in development.
Milestone 2	Tools for managing production risk and higher productivity and returns in use by growers.	30/06/3008	Yes, TopActive modules, WA Wheat and FertiPlan in use.		Publications placed with distributors with strong networks
Milestone 3	Over 1000 farmers and advisers trained in market requirements for wheat quality	30/06/3008	Yes, TopActive modules enable broader delivery		Promotion of publications in farm press will assist uptake.
Milestone 4	Research outcomes incorporated in accredited courses and publications for ongoing delivery.	30/06/3008	Yes, 13 texts for retail; 3 texts incorporating research outcomes in use in postgraduate courses at 2 universities.		Ongoing as new outcomes arise.

Table 3: Research Outputs and/or Milestones

3.23: Research Project 5.3.5: Novel Process for Novel Products

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 5.3.5.1	Assess process variables for waxy wheat	30/06/2007	Yes		
Milestone 5.3.5.2	Assess starch crystal structure and resistant starch formation	31/08/2007	No	Milestone not yet due.	Work in progress
Milestone 5.3.5.3	Assess the effect of protein	30/09/2007	No	Milestone not yet due.	Work in progress
Output 5.4	Submit thesis	31/12/2007	No	Not yet due.	Continue drafting and refining chapters

3.24: Research Project 5.3.6: PhDs by Research, in Plant Breeding

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 5.3.6.1	Perform QTL analysis for pentosans in selected DH lines	31/12/2006	Yes		
Milestone 5.3.6.2	Perform QTL analysis for sprouting tolerance in selected DH lines	31/03/2007	Yes		
Milestone 5.3.6.3	Perform final milling and quality testing	31/03/2007	No	Participant company's workload: unable to provide access to equipment	NSW DPI provided access after short delay
Output 5.5	Complete and submit thesis (D. Mercado-Escueta)	30/09/2006	Yes		
Output 5.6	Draft and submit thesis (S. Begum)	30/06/2007	No	Maternity leave	Will complete by June 2008.

3.25: Research Project 5.4.7: QTL for Yield, Grain Size, Milling Yield and Noodle Colour in AGT's Breeding Program

Output / Milestone Number	Description	Contracted Achievement Date	Achieved (Yes or No)	Reasons why not achieved (if applicable)	Strategies to achieve unmet milestones
Milestone 5.4.7.1	Multi site trials for 91 lines in two replicates across 6 sites in NSW	May 2006- Feb 2007	Yes		
Milestone 5.4.7.2	Quality testing on 91 lines	Jan-August 2006	Yes		

WHEAT CRC PERFORMANCE MEASURES

Effective management of scientific, commercialisation, education and financial performance is an integral component of the Centre's management. The considerable experience developed in the Quality Wheat CRC in monitoring these areas is being further refined in the Value Added Wheat CRC to provide high levels of performance review and management.

The Wheat CRC management is determined to reach and exceed as many as possible of the performance measures established in the Commonwealth Agreement. The list of performance measures below is taken from, and grouped, according to Schedule 6 of the Agreement. Progress each year is being quantified in the numbered bullet points (after each measure), to provide a cumulative record of the Centre's success in achieving objectives.

Table 7: Progress on Performance Measures (2000 Round CRCs)

Performance Indicator	Objective/Target	2001-02 Progress/ Achievement	2002-03 Progress/ Achievement
Objectives of the Centre			
Specific industry need	Involvement of industry managers (totalling one full-time equivalent) in running the integrated program.	In the first year, the Senior Management Group included representatives from Goodman Fielder (50%), Arnott's (10%), C-Qentec Diagnostics (10%) and the Grains Research and Development Corporation (GRDC - 10%). Four other members of the SMG have previously worked in industry, including the Managing and Commercial Directors (each 100%).	Though there have been changes of detail (Allied Mills being now represented in the Senior Management Group), the overall level of industry commitment has remained the same during the second year.
	Involvement of at least two overseas groups (commercial or research) in the program.	Active collaborations have been negotiated, or are in progress, with Monsanto (UK and USA), John Innes Centre (UK), The United States Department of Agriculture, and Cibus Genetics (USA and France). C-Qentec Diagnostics are negotiating distribution of WheatRite® and ReadRite® through commercial groups in Europe and the USA.	The previous year's collaborations have mostly continued into the second year and have gone well (especially the UK ones). We also have small collaborations in Argentina, Hungary and at Kansas State University, USA.
Economic development	Increasing dollar value of economic benefit to industry and participants (assessed by participants)	The benefits of consistent quality from the oven monitoring project have been estimated by commercial bakers at over $75,000 per annum in each bakery.	In a year of increasing "bottom line" focus amongst our commercial participants (caused by the drought, takeovers and divestments) we have convinced them of the short-term commercial value of certain projects (such as in the above example). In most cases we have been able to retain the commitment of their management to the CRC by demonstrating this. Allied Mills has, moreover, newly committed to core membership. Westons and C-Qentec have developed ambitious business plans based on CRC technology. AustGrains International has enthusiastically partnered with us to produce seven-figure dollar values of our speciality wheats.
	Increasing commitment of the industry as a whole to the Centre (number of participants and their aggregate cash and in-kind contribution).	Aggregate additional cash contributions to the Centre during the year (from GRDC, MasterFoods and George Weston Foods) amounted to over $622,000.	Additional cash contributions in the second year (from GRDC and George Weston Foods) totalled over $702,500. Aggregate in-kind contributions were running well ahead of the budget in the Commonwealth Agreement at the half-year point.

2003-04 Progress/Achievement	2004-05 Progress/Achievement	2005-06 Progress/Achievement	2006-07 Progress/Achievement
Again the overall level of industry commitment has remained similar. Increased involvement by Arnott's in project management has occurred.	Senior staff from Allied Mills, especially in Programs 1 and 4, have augmented further involvement by Arnott's staff in project management.	The total contribution by Allied Mills, Arnott's, Bayer, George Weston and GRDC staff to running the CRC program remains greater than the targeted full-time equivalent.	The level of commitment by industry managers to the Board and Senior Management committee has remained the same as in the previous year.
The previous collaborations have continued, the Argentine one having developed into a commercial relationship with the sale of seventy tonnes of certified seed.	Most previously recorded international collaborations have continued, this year there has been increased activity in the UK (eg with the National Institute of Agricultural Botany) and in France (Limagrain).	Most previously reported collaborations are continuing and we have started a new collaboration involving IRRI (Philippines) and CIMMYT (Mexico) to develop web-delivered software for high throughput marker data analysis. It is notable that almost half the orders for Triticarte® services have come from overseas (predominantly the United States and Europe), some from previous or current collaborators in CRC projects.	Overseas collaborations previously reported have mostly continued. The CIMMYT, Limagrain, UK and Triticarte® links have strengthened during the year in review.
Commitment has continued at previous levels, with acreages of our wheats planted by AustGrains and Westons increasing. Installation of the CRC's processing technology by Goodman Fielder in commercial bakeries has taken place.	Last year's specific achievements have been repeated at increasing levels. Revenues from our molecular marker service (Triticarte®) and other breeder technology were well over $200,000 in the first real year of commercialisation	Continued increases in the acreages of soft wheat and, particularly, Waxy wheat planted. Breeder technology uptake exceeds $500,000. Bayer has reaffirmed its commercial commitment to WheatRite®.	Most notable increases during the year have been in the uptake of breeder technology (particularly Triticarte®, CIMMYT germplasm coordination and LMA testing). As well there has been uptake of the CRC's variety diagnostic technology by industry from Program 1.
Aggregate cash contributions totalled $1,296,262 from similar sources as last year. In-kind contributions have continued to run well ahead of budget.	The steep rise in cash contributions of the previous three years has been consolidated this year ($1,250,000) and augmented by commercial revenues from Triticarte. In-kind contributions have again continued to run well ahead of budget, despite one participant giving notice of resignation from the Centre.	We have again consolidated cash contributions (Commonwealth Agreement plus additional) from industry participants on budget, despite the departure of Goodman Fielder from the Centre.	Budgeted cash and in-kind contributions from industry have again been augmented from commercial revenues and commercially-funded projects additional to the original Commonwealth Agreement.

Performance Indicator	Objective/Target	2001-02 Progress/ Achievement	2002-03 Progress/ Achievementt
Integration of research in different parts of the wheat value-added chain increasing over time.	Programs 1, 2, 4 and 5 have active involvement of managers and/or scientists from commercial Participants. The program 1 and 3 managers are approaching jointly the research towards new diagnostics. Industrial participants attended our internal conference and provided valuable comments on the annual operating plan. Consultation is a requirement in project design.	The high levels of integration established at the outset have been maintained (see the table in the Cooperative linkages section of the report).	Again high degrees of integration have been maintained (see the table of Cooperative linkages). Increased collaboration between programs 2 and 4 has resulted from work on germplasm with improved processing potential.
Quality and Relevance of the Research Programme			
Publications	Numbers of refereed journal, conference and other publications from CRC scientists maintained at current levels.	The first year's tally is 114 publications.	In the second year the list contains 107 publications.
	Centre scientists' invited presentations; home and overseas recognition of them maintained at current levels.	Contributions of this type continued at levels similar to those of the Quality Wheat CRC. Notably, CRC scientists contributed to two thirds of the papers in the Wheat Molecular Marker issue of the Australian Journal of Agricultural Research (Volume 52, 11/12, '01).	As before a number of Centre scientists have been prominent in Australian and overseas presentations and publications. One is Editor-in-Chief of, and a major contributor to a significant international publication, the Encyclopaedia of Grain Science, to be published in May 2004, as a three-volume set, plus two CDs and on-line version.
High quality research	Quality of science relative to overseas research (particularly in multinationals), assessment by overseas and/or multinational company and/or peer review.	Overseas scientists (including those in multinationals) have actively sought collaboration in wheat CRC programs (see above) – recognition of our contribution to global wheat science.	The second year situation is the same.
Strategy for Utilisation and Commercialisation of Research Outputs			
Utilisation and commercialisation	Maintenance of old commercialisation contracts and licence agreements and signing of new ones.	Major contracts have been signed/ maintained with C-Qentec Diagnostics (WheatRite®) and George Weston Foods ("waxy" wheats). We have also progressed agreements for commercial production of QAL2000ⓘ biscuit wheat and commercialisation of its improved sister lines.	In addition to maintaining last year's agreements (and adding QALBisⓘ biscuit wheat and other centre germplasm), we have negotiated a joint venture agreement covering Triticarte™; agreements to commercialise the z-arm mixer and the GreatGrain quality assurance system have also been advanced. A distribution agreement has been established for our grain storage CD, the contents of which are now a component of a University distance-learning course.

2003-04 Progress/Achievement	2004-05 Progress/Achievement	2005-06 Progress/Achievement	2006-07 Progress/Achievement
Again high degrees of integration have been maintained (see the table of Cooperative linkages). Increased collaboration between programs 2 and 4 has resulted from work on germplasm with improved processing potential.	The table of cooperative linkages again demonstrates that the very high standards of integration originally set have been maintained	The new-format table of cooperative linkages demonstrates that the very high standards of integration originally set have continued to be maintained. Senior staff participated in four GRDC subcommittees to integrate and provide future directions for coordinated Australian pre-breeding research, informatics, IP and management.	Every project in the CRC's portfolio (see the cooperative linkages table) involves more than one entity from the value-added chain.
Ninety-five publications are in the third year's list.	One hundred publications are cited in this year's list.	There are 112 publications of these types in this year's list.	There are 74 publications this year, comprising 54 peer-reviewed publications, 7 confidential technical reports, 10 non-reviewed conference papers and 3 newsletters.
The MD was invited to speak at an international conference on partnerships in international agricultural research, and a program manager received the Guthrie Medal for her contributions to cereals research in Australia. Another program manager has been promoted to Director of the Plant Breeding Institute in Sydney University. Progress with Triticarte science has been published in a prestigious peer reviewed journal internationally.	The MD was invited to address a working meeting of UK scientists engaged in integrating bioscience research with wheat improvement. Another CRC scientist was awarded a prize for scientific writing.	Demand from home and overseas for the Triticarte® molecular marker service has more than doubled and centre scientists are frequently asked to talk about it. A Food Innovation Grant was awarded by DAFF to one of the commercial partners senior technical staff to continue CRC initiated work on variety/quality identification.	Overseas interest in the Triticarte® service has increased sharply, especially from public and private sector institutions in Europe. Last year's Food Innovation Grant was extended. The CRC's involvement with the CIMMYT germplasm has focussed much attention on its science and on its Education and Technology Transfer Program.
Interest in collaboration on Triticarte™ technology has come from Europe and N America, from both multinationals and prominent public-sector researchers. One program manager was invited to an internal seminar at a multinational.	The centre's molecular marker work continues to attract interest from multinationals and prominent public-sector scientists including new ones not previously involved. An Australian-based multinational has shown interest in new gluten processing technology.	Interest from scientists (at home and overseas) in the centre's molecular marker work and in Triticarte® continues to increase and forms the largest single demonstration of the quality of science relative to overseas research, as assessed by overseas peer review.	A highly favourable, independent fifth year review of the whole of the CRC's activities was conducted during the period. The Triticarte® service was favourably reviewed by independent scientists on behalf of GRDC, and an overseas-based multinational company has begun an evaluation of it with a view to using it as its method of choice for its wheat and barley breeding.
The above contracts have continued during the third year. An agreement regarding the commercialisation of QAL2000(ℓ) and QALBis(ℓ) in South America has been signed.	The fourth year has mostly been spent maintaining and developing existing relationships, and no new major commercialisation contracts have been signed, though some were in advanced stages of negotiation (eg gluten processing technology).	The fifth year has also mostly been spent maintaining and developing existing relationships, and though no new major commercialisation contracts have been signed, one was re-activated (z-arm mixer prototype development).	A commmercialiation licence has been signed for the soft wheat line QAL1064(ℓ) and an agreement for QAL3362(ℓ) is in advanced negotiation. number of research agreements were begun with AWB, the International Rice Research Institute and the Australian Centre for Plant Functional Genomics (non-participants) and GRDC (participants).

Performance Indicator	Objective/Target	2001-02 Progress/ Achievement	2002-03 Progress/ Achievement
	Income from commercial users of the research per schedules 1 and 4 of the Commonwealth Agreement (from germplasm, diagnostics, educational and QA material etc).	Royalty and contract income from QAL2000(ↀ) and the WheatRite® and "waxy" agreements totalled $100,000 this year. Additional moneys were received from GRDC and MasterFoods for contract research this year (>$580,000). Educational publication and CD sales exceeded $1,200 last year, and workshop registrations of around $10,000 were received.	The second year's royalty and contract income from the same sources plus germplasm licensing totalled $760,709. Contract research income was $702,522. Income from educational activities amounted to $9,141.
	Returns from science and technology directly exploited by Participants (uptake of technology reported in Annual Report): • Diagnostics and markers in breeding • Process improvements • Agronomic knowledge • Quality Assurance technology • Genetic and physiological knowledge • Germplasm.	Process improvements are being implemented in mills and bakeries etc as direct results of Program 2 exploitation by Goodman Fielder (bakery process control) MasterFoods and others (microbiology). Commercial production of QAL2000(ↀ) has provided direct benefits to Goodman Fielder and Arnott's.	The second year has seen continuations of the above, and the dominant importance of the WheatRite™ and ReadRite™ technology platform in the business of C- Qentec (an SME). Allied Mills has begun to use Centre technology in forging its relations with its customers.
	Patents, trademark, copyright and other forms of IP protection (increasing portfolio, with costs borne by industry).	Plant Breeder's Rights ("ↀ") were sought for several types of new germplasm. The WheatRite® and ReadRite® patent and trademarks were maintained, with responsibility for 50% of the costs passing to C-Qentec.	We now have Plant Breeders' Rights (full or provisional) on two varieties and patent and trademark protection for the two rain damage products.
	Number and size of technology transfer workshops (per schedule 1 of the Commonwealth Agreement).	Sixty employees and secondees attended our internal conference in February 2002. A further sixty industry staff attended our Enzymes in Industry and Prebiotics workshops and ten wheat quality workshops reached 126 farmers.	In the second year we ran and sponsored thirteen workshops including three further quality courses for farmers. The combined total of industry attendees (including farmers) reached three hundred.

2003-04 Progress/Achievement	2004-05 Progress/Achievement	2005-06 Progress/Achievement	2006-07 Progress/Achievement
Contract research receipts were $250,621; research grants totalled $947,710; royalties and license fees came to $85,600 and sundry receipts (mostly educational fees and materials) totalled $12,331.	Receipts of similar amounts were made in each of the categories mentioned for last year, except royalties and licence fees, which were almost doubled when income from Triticarte services is taken into account.	Similar overall levels of contract research, grants, royalties and licence fees were earned as in previous years. Triticarte® income more than doubled again.	Overall levels of contract research, grants, royalties and licence fees were similar to previous years. Triticarte® commercial income increased by 20% on the previous year.
In the third year, the previous uptake has continued. Commitment to the "test driving" of the Triticarte™ technology has been a major new feature with uptake by all the Participants having interests in wheat breeding. Uptake of the soft wheat germplasm was discussed in a special workshop convened for Participant companies and collaborators.	The "test drivers" of Triticarte® have turned into customers. Partners are also exploiting our specialist wheats on an increasing scale: Twenty percent of Arnott's output from one factory is CRC wheat, and George Weston have important product development plans based on our waxy wheat. Participant Allied Mills and external organisation GrainCorp are taking up diagnostic technology developed in the CRC to add value to harvested wheat and milled flour by matching properties to the precise requirements of food manufacturers. Our diagnostic technology is a vital platform in another participant's (C-Qentec) business development plans. Goodman Fielder has continued to install our processing improvement technology.	The major examples listed for year 4 have been consolidated in most cases. The number of Triticarte® customers has increased sharply; Arnott's and George Weston have used more of our specialist wheat, in the latter case for pilot manufacture and marketing. Although Goodman Fielder is no longer in the CRC, another commercial participant initiated a new project on the shelf life of modified atmosphere packaged wheat products.	The previous year's examples have continued satisfactorily. The packaging project reached a conclusion as did a receival quality project for Allied Mills and its parent company.
Patent protection for WheatRite® has been granted in Europe and is progressing in N America. We continue to manage the IP portfolio prudently, where costs cannot yet be shared by industry.	Whilst maintaining the existing portfolio prudently (and where possible at the industry's expense) we have written (and in some cases filed) new provisional patents in the diagnostics and gluten processing areas. We have started new applications for Plant Breeders' Rights on the waxy wheats, and have received trademark protection for Triticarte®.	During the fifth year, the United States patent for WheatRite® was finally granted after a rejection by the US examiner had been successfully opposed. The patenting of our method for improving the quality of gluten extracted from wheat was abandoned and re-filed. As well, new provisional patent applications were filed on the two "GBSS" antibodies, and PBR ("ⅅ") applications were filed for three new varieties of Waxy wheat and a triticale variety. We maintained all older patents, PBR applications and trademarks (mostly at the industry's expense).	Although the IP policy is changing towards the end of the Commonwealth contract, and we have now abandoned a number of patents for which the cost of maintenance exceeds the likely return, we have continued to expand the scope of the WheatRite® patent family as well as increasing the number of varieties with Plant Breeder's Rights ("ⅅ") protection.
Four workshops with over one hundred participants plus three quality courses for farmers were held. These have been particularly targeted at transfer of technology generated in the wheat CRC. We also held an internal conference attended by sixty participants this year.	Two technical (47 attendees) and one postgraduate workshop (12 attendees) were held during the year plus a pilot short course in grain marketing awareness in which seven farmers participated. Six more technical workshops are in the planning stage, two for early July.	Eight successful technical workshops (183 attendees) presented by national and international guest speakers were run. We held a further 4-day postgraduate workshop covering project and team management, IP, commercialisation and scientific writing. This was attended by 15 VAWCRC and Grain Foods CRC postgraduate students and staff.	Four technical workshops were run successfully (152 attendees), featuring our diagnostics team and international guest speakers in collaboration with the RACI - Cereal Chemistry Division. We also ran two interactive forums with plant breeders (94 attendees) and participated in two high-level reviews related to technology transfer and Plant Breeder's Rights. A further three workshops are planned early in 2007-2008.

Performance Indicator	Objective/Target	2001-02 Progress/ Achievement	2002-03 Progress/ Achievement
	Steady flow of technology-transfer publications and decision aids for industry reported in the Annual Report.	We produced manuals for the workshops, and supported publication of a set of six "Agnotes", 4 farm budget handbooks and a durum wheat package for farmers, in addition to revised public and internal web sites.	In the second year detailed manuals were produced for all workshops and courses. We sponsored and published grower manuals on agronomy ("FertiPlan") and grain storage ("Stalk to Store") and started work on educational materials for cereal scientists; most of these incorporate Centre research outcomes.
	Contract research agreements and consultancies in increasing numbers.	Major agreements this year (detailed above) with C-Qentec, George Weston Foods, AustGrains and GRDC.	During the second year we have been negotiating new agreements with several wheat breeders, AustGrains, GRDC, Newport Scientific, AWB Ltd, CAMBIA (DArT P/L) and Kansas State University.
Education and Training			
Postgraduate education	PhD student numbers to targets in schedule 1 of the Commonwealth Agreement.	There are eight postgraduate students at present in the Centre, of whom five have started in the year under review.	Three new postgraduates were appointed in the second year. Three others have finished their studies during the year.
	Industry co-supervision of two-thirds of students also spending time in industry.	All VAWCRC students are co-supervised by university and State Department of Agriculture scientists, and participate in project meetings focussing on end-use and industry requirements.	Co-supervision continues, all the three new student projects having commercial application (and one of them based in a commercial laboratory).
Collaborative Arragements			
Collaborative participation	Three quarters of projects with multiple, commercial and/or overseas participants/sites.	Ninety-five percent of current projects are multi-participant, one-third involves commercial participants and four projects (about 20%) involve overseas participants.	In the second year of its operation, the Centre's collaborative profile has been maintained; it now has a larger number of core participants than in the first year (see the table in the Cooperative linkages section of the report).
	Increasing leverage of Commonwealth funds from industry sources.	The royalty income and contract research income detailed above has increased the leverage of Commonwealth cash funds.	The budgeted "other cash" contribution to the Centre's income increased in the second year, and the target was eventually exceeded.

2003-04 Progress/Achievement	2004-05 Progress/Achievement	2005-06 Progress/Achievement	2006-07 Progress/Achievement
A set of manuals for the implementation of OptiDough™ were produced and IP supporting the industry use of Triticarte™ was developed.	Triticarte IT development continued and pattern matching software for grain proteins was developed by enhancing several existing programs. Three Topactive workshop kits were published for farm advisers nationally. A book outlining key terms and concepts in genetics, plant breeding and bioIT was published and ongoing requests for our safe noodle manufacture guidelines were received.	This year saw further development of the IT system supporting the Triticarte service. We also commenced a project to make similar analysis of data from the new CIMMYT germplasm trial project widely available to breeders. A final VAWCRC-sponsored workshop kit was published in the TOPACTIVE series for farmers.	The focus this year was again on the IT system supporting the Triticarte service, and on the project to make similar analysis of data from the CIMMYT germplasm trial project widely available to breeders. The book on Population Plant Breeding is progressing well.
Progress has been made with the above, with the Weston, AustGrains, GRDC and CAMBIA (DArT P/L) ones being particularly significant. An agreement with the Wheat Quality Network (Argentina) has been the largest new initiative.	The fourth year has mostly been spent maintaining and developing existing relationships, and no new major contract research agreements and consultancies have been signed, though there are some in advanced stages of negotiation (eg Manildra).	The fifth year has also mostly been spent maintaining and developing existing relationships, and no new major contract research agreements and consultancies have been signed, though one was re-activated (z-arm mixer prototype development). A contract IT development agreement to upgrade the International Crop Information System so it can handle Triticarte® (DArT®) marker data was signed with the International Rice Research Institute, who will collaborate with us, the University of Queensland, and CIMMYT's Research Informatics Laboratory.	A number of new research agreements were begun with AWB, the International Rice Research Institute and the Australian Centre for Plant Functional Genomics (non-participants) and with GRDC (participants).
New starts and plans laid during the third year will ensure that we meet the targets in the Commonwealth Agreement during the life of the CRC.	Eight new students were appointed, and there are plans to appoint a further seven over the coming year, which will bring the total to 32, exceeding our target. Four are currently writing their PhD theses. Twelve students attended our four-day postgraduate workshop.	Six new postgraduate students were appointed and one withdrew to take up an attractive job opportunity, which brings the total to 30 VAWCRC postgraduates with 6 in industry, achieving our target. Five of our students submitted their theses and two are currently writing up.	One PhD student withdrew, bringing our total to 29 VAWCRC postgraduates with 6 in industry. We are also sponsoring a high-level operations manager, in a position to apply the techniques so learned, in a part-time Graduate Certificate in quantitative methods. Four students submitted their theses and seven are writing up.
A major initiative to train six wheat breeders for the industry has commenced, with co-supervision and involvement in the latest high-technology developments in the industry.	Industry co supervision has continued to be the rule with the new starting and planned studentships. Six are located in industry and this target will be exceeded over the coming year.	All students are either directly co-supervised by industry participants or are exposed regularly to industry by positioning their projects as part of a larger industry initiative.	The same situation as last year has applied.
The Centre's collaborative profile has again been maintained, even though the number of core participants has reverted to eight (see the table in the Cooperative linkages section of the report).	Almost ninety percent of projects have multiple, commercial and/or overseas participants/sites (see the table in the Cooperative linkages section of the report).	Even though the number of core participants has gone down to seven, the Centre's collaborative profile has again been maintained with ninety three percent of projects having multiple, commercial or overseas participants/sites.	The Centre's collaborative profile has again improved with every project in the CRC's portfolio involving more than one research, commercial or overseas participant/site.
The "other cash" line has continued to exceed the Commonwealth agreement.	Although the "other cash" line this year has fallen slightly below the Commonwealth Agreement, income brought in to the industry by Triticarte activities has made up the difference.	The "other cash" line has exceeded the Commonwealth agreement once again (the cumulative excess now exceeds $500,000) and income brought in to the industry by Triticarte® activities has improved on the "over-delivery".	The "other cash" line has exceeded the Commonwealth Agreement and income brought in by Triticarte® activites has continued to increase.

Performance Indicator	Objective/Target	2001-02 Progress/ Achievement	2002-03 Progress/ Achievement
	Ownership of projects by Participants' management and staff (manifested by involvement of Centre Management in annual performance appraisals of seconded staff).	Only informal appraisals have taken place. However it has been agreed that the MD will participate in the replacement/recruitment process in the University.	Whilst there is no doubt about the commitment of seconded managers and staff to Centre projects, there has been little progress in getting Centre Management involved in Participants' performance appraisal processes during the second year. A policy to provide secondees' organisations with a statement of recognition of confidential internal CRC reports has been implemented, initially where permission to publish has been denied.
Resources and Budget			
Sound resource management	Cash and in-kind budgets achieved or exceeded (per schedule 1 of the Commonwealth Agreement).	Both cash and in-kind budgets are close to contract; an intentional underspend on cash (2-3%) is to allow flexibility in research planning for future years.	For a second year, both cash and in-kind outcomes appear better than budget. The continued cash underspend is planned for use in year three.
	Numbers of scientific and support staff engaged on Centre projects (per schedule 4 of the Commonwealth Agreement).	Achieved. In the University there have been far-reaching staffing changes, but the overall in-kind contribution has stayed close to budget.	The numbers were achieved again in the second year, despite the University's recruitment processes being slower than expected.
	Timeliness, flexibility and transparency of budget allocation decisions by Centre Management.	The commercial evaluation of individual projects has begun, led by the Commercial Director and the Senior Management Group. Several Directors attended a workshop to finalise the Operating Plan, and all Commercial Participants were represented and provided input.	During year two, the Centre's business strategy was finalised, and this contributed to the comprehensive nature of the planning of the budget for year three. As a result of adding this to the normal planning process, CRC directors and participants' senior managers all had opportunity to contribute fully to budget allocation.
Management Structure			
Board involvement in commercialisation decsions	Active case-by-case decision making on commercialisation at Board level.	Specific Board approval has been obtained for the George Weston Foods ("waxy" wheat) agreement and general approval has been given for the Supporting Participants' agreements. The specifics of the Commercialisation clauses in the Centre Agreement were finalised during the year in review by the Board.	During this second year, the Board has been involved in decision-making over the development of agreements covering the commercialisation of wheat germplasm and varieties, the Triticarte™ joint venture (the Centre's molecular marker technology) and the commercialisation of the Great Grain quality assurance system.

2003-04 Progress/Achievement	2004-05 Progress/Achievement	2005-06 Progress/Achievement	2006-07 Progress/Achievement
During the third year, the situation has remained unchanged.	During the fourth year also, the situation has remained unchanged. However, the recruitment and career development plans of two participants' (one each commercial and research provider participants) for scientists seconded to the CRC were directly and positively influenced.	The situation has stabilised as described for year 2.	The situation has remained stabilised as described for earlier years.
Again cash and in-kind outcomes are better than budget. Cash flow remains healthy, despite use of some reserves in the setting up of Triticarte™, and small (budgeted) overruns in the project expenditure 03-04 and projected in the Annual Operating Plan for 04-05.	Overall, cash and in-kind outcomes are comparable to or better than budget. Cash flow is healthy, despite an overrun projected in the Annual Operating Plan for 05-06.	Cash and in-kind outcomes are, respectively, comparable to (within 1%) and better than budget. Cash flow remains healthy, despite an overrun on research expenditure in the year.	The cash outcome was slightly better than budget and in-kind contributions from Core Participants exceeded budget. Cash flow remains healthy.
Achieved	Achieved	Achieved	Achieved
Again, CRC directors and participants' senior managers all had opportunity to contribute fully to budget allocation after the basic outline had been negotiated and agreed in the Senior Management Group.	The process for establishing projects and budgets that has been used in the past three years has continued only slightly modified. The senior management group (including representatives of all the participants) essentially draws up and agrees the budgets, in consultation with staff in their organisation, and the Board has opportunity to consider the draft Operating Plan. This year as in all previous years, small changes have been made passim authorised by the MD affecting less than 5% of the research budget.	Centre Management has used the same timely, flexible and transparent budget allocation processes as in previous years.	Centre Management has continued to use the same timely, flexible and transparent budget allocation processes as in previous years. Despite the approaching end of the Commonwealth contract, some funds were reallocated to critical new projects, and decisions were made as to which projects should be terminated, and when, after discussion and agreement by the Senior Management Group and the Board.
There has been Board involvement this year with the negotiation of new agreements regarding commercialisation of wheat varieties, both at home and overseas.	Because the fourth year has mostly been spent maintaining and developing existing relationships, no new major contracts, research agreements or consultancies have been signed. However the Board has been kept abreast of all developments in on-going contracts and negotiations about new ones.	Decision making at Board level has been conducted as before.	With the approaching end of the Commonwealth contract, there has been very close discussion with the Board and approval obtained on all aspects of commercialisation.

Performance Indicator	Objective/Target	2001-02 Progress/ Achievement	2002-03 Progress/ Achievement
Performance Evaluation			
Sound evaluation process	Meeting and reporting against project milestones and outcomes.	The Senior Management Group has monitored quarterly project reporting and achievement of milestones. A schedule of Program reviews by the SMG and by the Board has begun during the year in review.	The process of reviewing the Centre's science and education programs at Board and Senior Management level continued in year two. The MD and Commercial Director have attended the majority of individual program management meetings.

Table 7.1:

Specific performance indicators relating to the scientific program of the Centre were drawn up and appear in Schedule Six of the Commonwealth Agreement. These are listed in the table below (slightly modified to account for changed objectives in ensuing years as previously reported).

Achievement is assessed in the right hand column on a scale of 1-5, where: 1 = Progress greatly exceeding expectations
2 = Progress exceeding expectations
3 = Progress on track
4 = Slower progress than expected
5 = Little or no progress.

Where N/A is written, it was too soon or inappropriate to assess achievement.

Program - Performance Indicator	Measurement Criteria	Achievements by Year					
Program 1: Diagnostics		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Flow of new quality diagnostic tests as demanded by industry.	New test available every 2-3 years.	2	2	3	4	3	2
Latest world-class science being deployed.	Number of licensing agreements.	3	3	3	3	3	2
	Royalty/income flow to Centre.	3	3	3	2	4	4
	Uptake by international organisations.	3	2	3	3	3	3
Program 2: Products and Processing							
Practical methods for blending to enhance quality.	Number of organisations employing technology.	2	N/A	2	2	2	2
Innovative applications of speciality wheats	Novel foods and wheat-derived products.	N/A	3	3	2	2	2
	Improved efficiency and reduced wastage in processing.	2	2	2	2	3	2
	Improvements to product quality, revenue or profit resulting from enhanced processing technology.		2	2	2	3	3
Program 3: Genomics and Proteomics							
New genes for wheat quality detected.	Number of new genes identified.	2	2	2	1	1	1
New environmental determinants of quality detected.	Annual increase in rate of uptake by Germplasm Program.	1	1	1	1	1	1
Acceleration of application of molecular markers to improved wheat quality.	Increased uptake of enhanced marker and other biotechnology by wheat breeding programs.	N/A	3	2	2	2	1
Program 4: Germplasm and Varieties							
Improved application of agronomic knowledge by growers.	New germplasm available to breeders.	1	1	1	1	1	1
Wheats with specific qualities beneficial for processing.	VAWCRC germplasm appearing in wheat varieties throughout Australia.	N/A	3	3	3	3	2
	Quality varieties more rapidly available to growers.	2	2	2	2	2	2
	Genetic stocks with novel qualities available to breeders.	2	2	2	2	2	2

2003-04 Progress/Achievement	2004-05 Progress/Achievement	2005-06 Progress/Achievement	2006-07 Progress/Achievement
The centre's science was reviewed extensively and very positively during the Second Year Review. The MD and Commercial Director continue to supervise individual program meetings.	The Senior Management Group has continuously monitored quarterly project reporting and achievement of milestones. A schedule of Program reviews by the SMG was completed during the year in review. The MD and Commercial Director continue to supervise individual program and some individual project meetings.	A conference of the scientists in the CRC was held in February; at this progress in all projects was reviewed. The MD and Research Director supervise individual program and some individual project meetings. The Senior Management Group has sustained their continuous monitoring of quarterly project reporting and achievement of milestones.	The MD and Research Director have continued to supervise individual programs (eg by site visits) and individual project and program meetings. The Senior Management Group has sustained its continuous monitoring of quarterly project reporting and achievement of milestones.

Program 5: Education and Technology Adoption							
Number of postgraduates trained.	Postgraduate students fill all appropriate positions.	3	3	3	2	3	3
	Target of 15 PhDs per 3 years.	3	3	2	2	3	3
	Postgraduates familiar with IP- and business management.	3	3	3	3	3	3
Uptake of Centre generated knowledge.	Participants and trainees report effective uptake of Centre generated knowledge.	3	3	3	2	2	2
	Number of workshops/seminars – minimum of 6 per year	2	1	1	2	2	3
Business Management							
Effective use of resources.	Competitive tendering for projects.	3	3	3	3	3	3
Commercialisation of outputs as planned.	Quantitative commercial measures and portfolio analysis used to assess and rank projects.	N/A	2	2	2	3	3
	New commercialisation agreements negotiated or signed.	N/A	2	2	2	3	2
	Increased size of intellectual property portfolio.	N/A	3	2-3	2	2	3
	Adherence to budgets and compliance guidelines.	N/A	2	2	2	2	2
	Commencement of Strategic Alliances/ Joint Ventures as called for in the Business Strategy	N/A	N/A	1	2	2	2
Collaborative Arrangements							
Proportion of projects with multi-site collaboration.	Majority of projects with multi site collaboration of research or postgraduate student supervision.	1	1	1	1	1	1
	Minimum of 80% of all publications to be by multi-party contribution.	1	1	1	1	1	1

The Performance Indicators and Measurement Criteria in the above table require modification as the Centre progresses. In the first year, we focussed on revising the commercial and business structure of the Centre whilst building and maintaining momentum in the science and education programs. In the second year we concentrated on finalising our business strategy and implementing some of its primary conclusions. In the third, fourth and fifth years we maintained and where possible increased the momentum in the different elements of the strategy. In the sixth year we have begun to focus on ensuring funds are available to maximise commercial benefit from those projects that can be expected to deliver it within the term of the Commonwealth contract whilst managing the wind-down of others and hitting educational and training performance targets.

Table 8: Cash Contributions

	ACTUAL							CUMULATIVE				GRAND TOTAL		
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2006/07	TOTAL TO DATE		2007/08	2007/08	Total	Agr'mt	Diff.
	Actual	Actual	Actual	Actual	Actual	Actual	Agr'mt	Actual	Agr'mt	Budget	Agr'mt	7 Yrs	7 Yrs	7 Yrs
CORE PARTICIPANTS														
Arnott's Biscuits Ltd	120.0	120.0	120.0	120.0	120.0	120.0	120.0	720.0	720.0	120.0	120.0	840.0	840.0	0.0
Bayer CropScience	100.0	100.0	100.0	100.0	100.0	100.0	100.0	600.0	600.0	100.0	100.0	700.0	700.0	0.0
Goodman Fielder	200.0	200.0	75.0	125.0	0.0	0.0	0.0	600.0	600.0	0.0	0.0	600.0	600.0	0.0
GRDC	750.0	750.0	750.0	750.0	750.0	750.0	750.0	4,500.0	4,500.0	500.0	750.0	5,000.0	5,250.0	-250.0
University of Sydney	300.0	300.0	300.0	0.0	0.0	0.0	0.0	900.0	900.0	0.0	0.0	900.0	900.0	0.0
Dept. Agriculture & Food WA	100.0	100.0	200.0	0.0	100.0	100.0	100.0	600.0	600.0	100.0	100.0	700.0	700.0	0.0
GrainCorp	100.0	100.0	50.0	0.0	0.0	0.0	0.0	250.0	250.0	0.0	0.0	250.0	250.0	0.0
Allied Mills	0.0	75.0	100.0	100.0	100.0	100.0	100.0	475.0	400.0	100.0	100.0	575.0	500.0	75.0
TOTAL CASH FROM CORE PARTICIPANTS	1,670.0	1,745.0	1,695.0	1,195.0	1,170.0	1,170.0	1,170.0	8,645.0	8,570.0	920.0	1,170.0	9,565.0	9,740.0	-175.0
OTHER CASH														
Non-participants	0.0	307.2	4.2	0.0	17.0	0.0	150.0	328.4	750.0	0.0	150.0	328.4	900.0	-571.6
External Grants	557.6	599.3	947.7	643.0	912.0	824.7	400.0	4,484.3	2,548.0	572.1	400.0	5,056.4	2,948.0	2,108.4
Contract Research	0.0	0.0	250.6	331.0	271.0	280.4	350.0	1,133.0	1,395.0	276.3	350.0	1,409.3	1,745.0	-335.7
Commercialisation	52.8	54.2	101.1	104.0	143.0	265.7	571.0	720.8	2,372.0	153.0	966.0	873.8	3,338.0	-2,464.2
Education	19.2	11.3	7.6	7.9	17.0	24.5	0.0	87.5	0.0	7.3	0.0	94.8	0.0	94.8
Interest	30.9	54.0	83.0	84.1	80.0	87.8	0.0	419.8	0.0	20.0	0.0	439.8	0.0	439.8
TOTAL OTHER CASH	660.5	1,026.0	1,394.2	1,170.0	1,440.0	1,483.1	1,471.0	7,173.8	7,065.0	1,028.7	1,866.0	8,202.5	8,931.0	-728.5
CRC GRANT	2,330.0	3,000.0	3,000.0	3,000.0	2,700.0	1,900.0	1,900.0	15,930.0	15,930.0	1,250.0	1,250.0	17,180.0	17,180.0	0.0
TOTAL CASH CONTRIBUTION	4,660.5	5,771.0	6,089.2	5,365.0	5,310.0	4,553.1	4,541.0	31,748.8	31,565.0	3,198.7	4,286.0	34,947.5	35,851.0	-903.5

Table 9: In Kind Contributions

	ACTUAL							CUMULATIVE				GRAND TOTAL		
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2006/07	TOTAL TO DATE		2007/08	2007/08	Total	Agr'mt	Diff
	Actual	Actual	Actual	Actual	Actual	Actual	Agr'mt	Actual	Agr'mt	Budget	Agr'mt	7 Yrs	7 Yrs	7 Yrs
CORE PARTICIPANTS														
Arnott's Biscuits Ltd														
SALARIES	55.5	71.9	92.2	70.4	88.5	55.2	60.0	433.7	357.8	24.4	60.0	458.1	417.8	40.3
OTHER	63.2	81.9	105.1	117.9	148.2	92.5	140.0	608.8	694.3	34.3	140.0	643.1	834.3	-191.2
OTHER CONTRIBUTIONS	7.0	15.0	23.8	9.3	0.8	0.0	0.0	55.9	71.6	3.1	0.0	59.0	71.6	-12.6
TOTAL	125.7	168.8	221.1	197.6	237.5	147.7	200.0	1,098.4	1,123.7	61.8	200.0	1,160.2	1,323.7	-163.5
Bayer CropScience														
SALARIES	41.2	17.5	26.2	19.6	25.0	23.4	50.0	152.9	281.7	4.5	50.0	157.4	331.7	-174.3
OTHER	30.3	17.5	26.2	33.6	43.0	40.2	50.0	190.8	281.7	5.6	50.0	196.3	331.7	-135.4
OTHER CONTRIBUTIONS	18.6	0.0	0.0	5.4	5.8	3.0	25.0	32.8	125.0	1.0	25.0	33.8	150.0	-116.2
TOTAL	90.1	35.0	52.4	58.6	73.8	66.6	125.0	376.5	688.4	11.0	125.0	387.5	813.4	-425.9
Goodman Fielder														
SALARIES	49.0	26.8	89.3	36.1	0.0	0.0	0.0	201.2	195.0	0.0	0.0	201.2	195.0	6.2
OTHER	58.8	32.2	107.1	63.9	0.0	0.0	0.0	262.0	235.0	0.0	0.0	262.0	235.0	27.0
OTHER CONTRIBUTIONS	206.0	158.9	28.0	0.0	0.0	0.0	0.0	392.9	0.0	0.0	0.0	392.9	0.0	392.9
TOTAL	313.8	217.9	224.4	100.0	0.0	0.0	0.0	856.1	430.0	0.0	0.0	856.1	430.0	426.1
GRDC														
SALARIES	233.6	18.7	18.1	12.8	7.0	6.4	35.0	296.6	208.1	0.0	35.0	296.6	243.1	53.5
OTHER	467.1	37.3	36.1	1.7	1.8	1.7	70.0	545.7	428.0	0.0	70.0	545.7	498.0	47.7
OTHER CONTRIBUTIONS	70.8	1,131.2	615.7	543.2	0.0	0.0	10.0	2,360.9	50.0	0.0	10.0	2,360.9	60.0	2,300.9
TOTAL	771.5	1,187.2	669.9	557.7	8.9	8.1	115.0	3,203.2	686.1	0.0	115.0	3,203.2	801.1	2,402.1
NSW Dept of Primary Industries														
SALARIES	389.0	524.4	345.5	236.4	290.6	301.8	450.0	2,087.7	2,652.3	177.1	450.0	2,264.8	3,102.3	-837.5
OTHER	546.1	1,012.0	666.9	715.9	880.2	914.1	630.0	4,735.1	3,926.5	401.7	630.0	5,136.8	4,556.5	580.3
OTHER CONTRIBUTIONS	421.1	744.8	1,236.3	1,047.7	967.2	1,109.5	170.0	5,526.6	850.0	468.8	170.0	5,995.4	1,020.0	4,975.4
TOTAL	1,356.2	2,281.2	2,248.7	2,000.0	2,137.9	2,325.4	1,250.0	12,349.4	7,428.8	1,047.6	1,250.0	13,397.0	8,678.8	4,718.2

Table 9: In Kind Contributions continued

	ACTUAL							CUMULATIVE				GRAND TOTAL		
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2006/07	TOTAL TO DATE		2007/08	2007/08	Total	Agr'mt	Diff
	Actual	Actual	Actual	Actual	Actual	Actual	Agr'mt	Actual	Agr'mt	Budget	Agr'mt	7 Yrs	7 Yrs	7 Yrs
University of Sydney														
SALARIES	148.2	205.9	345.4	267.8	298.0	293.7	200.0	1,559.0	1,191.3	305.6	200.0	1,864.6	1,391.3	473.3
OTHER	306.7	333.2	613.8	792.9	882.2	869.4	414.0	3,798.2	3,595.5	744.6	414.0	4,542.8	4,009.5	533.3
OTHER CONTRIBUTIONS	776.3	910.0	1,408.1	1,492.4	1,722.0	194.0	1,086.0	6,502.8	5,430.0	1,274.7	1,086.0	7,777.5	6,516.0	1,261.5
TOTAL	1,231.2	1,449.1	2,367.3	2,553.1	2,902.2	1,357.1	1,700.0	11,860.0	10,216.8	2,324.9	1,700.0	14,184.9	11,916.8	2,268.1
Dept. Agriculture & Food WA														
SALARIES	177.0	144.9	165.6	104.2	109.8	112.2	300.0	813.7	1,771.6	32.1	300.0	845.8	2,071.6	-1,225.8
OTHER	258.1	210.1	240.1	222.7	310.7	309.6	437.4	1,551.4	3,006.8	61.3	437.4	1,612.6	3,444.2	-1,831.6
OTHER CONTRIBUTIONS	169.7	299.3	317.1	215.4	267.9	290.0	392.6	1,559.4	1,963.0	61.6	392.6	1,621.0	2,355.6	-734.6
TOTAL	604.8	654.3	722.8	542.3	688.5	711.8	1,130.0	3,924.5	6,741.4	155.0	1,130.0	4,079.5	7,871.4	-3,791.9
ALLIED MILLS														
SALARIES	0.0	17.0	47.0	45.7	14.4	29.4	30.0	153.5	120.0	21.0	30.0	174.5	150.0	24.5
OTHER	0.0	20.4	56.4	80.9	25.5	52.1	20.0	235.3	80.0	32.1	20.0	267.4	100.0	167.4
OTHER CONTRIBUTIONS	0.0	39.3	176.2	287.2	264.2	234.0	0.0	1,000.9	0.0	136.6	0.0	1,137.5	0.0	1,137.5
TOTAL	0.0	76.7	279.6	413.8	304.1	315.5	50.0	1,389.7	200.0	189.7	50.0	1,579.4	250.0	1,329.4
TOTAL CORE IN-KIND CONTRIBUTIONS														
SALARIES	1,093.5	1,027.1	1,129.3	793.0	833.3	822.1	1,125.0	5,698.3	6,777.8	564.7	1,125.0	6,263.0	7,902.8	-1,639.8
OTHER	1,730.3	1,744.6	1,851.7	2,029.5	2,291.6	2,279.6	1,761.4	11,927.3	12,247.8	1,279.5	1,761.4	13,206.8	14,009.2	-802.4
OTHER CONTRIBUTIONS	1,669.5	3,298.5	3,805.2	3,600.6	3,227.9	1,830.5	1,683.6	17,432.2	8,489.6	1,945.9	1,683.6	19,378.1	10,173.2	9,204.9
TOTAL (IN-KIND)	4,493.3	6,070.2	6,786.2	6,423.1	6,352.8	4,932.2	4,570.0	35,057.8	27,515.2	3,790.0	4,570.0	38,847.8	32,085.2	6,762.6
SUPPORTING PARTICIPANTS														
APAF														
SALARIES	10.5	13.1	14.7	9.5	0.0	0.0	20.0	47.8	117.7	0.0	20.0	47.8	137.7	-89.9
OTHER	15.7	19.7	22.1	22.8	0.0	0.0	30.0	80.3	176.5	0.0	30.0	80.3	206.5	-126.2
OTHER CONTRIBUTIONS	0.0	0.0	0.0	95.6	0.0	0.0	0.0	95.6	0.0	0.0	0.0	95.6	0.0	95.6
TOTAL	26.2	32.8	36.8	127.9	0.0	0.0	50.0	223.7	294.2	0.0	50.0	223.7	344.2	-120.5
BRI														
SALARIES	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	89.7	0.0	15.0	0.0	104.7	-104.7
OTHER	0.0	0.0	0.0	0.0	0.0	0.0	11.3	0.0	67.6	0.0	11.3	0.0	78.9	-78.9
OTHER CONTRIBUTIONS	32.8	28.0	28.4	0.0	0.0	0.0	0.7	89.2	3.5	0.0	0.7	89.2	4.2	85.0
TOTAL	32.8	28.0	28.4	0.0	0.0	0.0	27.0	89.2	160.8	0.0	27.0	89.2	187.8	-98.6

Table 9: In Kind Contributions continued

	ACTUAL							CUMULATIVE				GRAND TOTAL		
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2006/07	TOTAL TO DATE		2007/08	2007/08	Total	Agr'mt	Diff
	Actual	Actual	Actual	Actual	Actual	Actual	Agr'mt	Actual	Agr'mt	Budget	Agr'mt	7 Yrs	7 Yrs	7 Yrs
CAMBIA/DArT														
SALARIES	17.6	27.2	0.0	0.0	0.0	0.0	30.0	44.8	172.7	4.2	30.0	49.0	202.7	-153.7
OTHER	31.7	48.9	0.0	0.0	0.0	0.0	45.0	80.6	265.8	7.5	45.0	88.1	310.8	-222.7
OTHER CONTRIBUTIONS	48.8	156.0	337.2	249.5	0.0	0.0	0.0	791.5	0.0	73.8	0.0	865.3	0.0	865.3
TOTAL	98.1	232.1	337.2	249.5	0.0	0.0	75.0	916.9	438.5	85.5	75.0	1,002.4	513.5	488.9
CRC Molecular Plant Breeding														
SALARIES	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	58.9	0.0	10.0	0.0	68.9	-68.9
OTHER	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	83.9	0.0	15.0	0.0	98.9	-98.9
OTHER CONTRIBUTIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	142.8	0.0	25.0	0.0	167.8	-167.8
Curtin University														
SALARIES	5.8	10.3	46.1	48.4	50.3	13.4	20.0	174.3	116.3	5.9	20.0	180.2	136.3	43.9
OTHER	9.0	15.9	71.4	109.6	113.9	30.3	30.0	350.1	178.7	11.8	30.0	361.9	208.7	153.2
OTHER CONTRIBUTIONS	0.0	0.0	0.0	4.6	3.7	0.0	0.0	8.3	0.0	0.3	0.0	8.6	0.0	8.6
TOTAL	14.8	26.2	117.5	162.6	167.9	43.7	50.0	532.8	295.0	18.0	50.0	550.8	345.0	205.8
Food Science Australia														
SALARIES	18.7	20.2	0.0	0.0	0.0	0.0	30.0	38.9	172.0	0.0	30.0	38.9	202.0	-163.1
OTHER	27.6	32.4	0.0	0.0	0.0	0.0	40.0	60.0	235.1	0.0	40.0	60.0	275.1	-215.1
OTHER CONTRIBUTIONS	33.1	96.2	122.5	429.4	150.2	211.3	0.0	1,042.7	0.0	0.0	0.0	1,042.7	0.0	1,042.7
TOTAL	79.4	148.8	122.5	429.4	150.2	211.3	70.0	1,141.6	407.1	0.0	70.0	1,141.6	477.1	664.5
PIRSA														
SALARIES	137.8	88.5	44.3	0.0	0.0	0.0	180.0	270.6	1,061.3	0.0	180.0	270.6	1,241.3	-970.7
OTHER	220.5	141.6	71.0	0.0	0.0	0.0	270.0	433.1	1,608.2	0.0	270.0	433.1	1,878.2	-1,445.1
OTHER CONTRIBUTIONS	0.0	69.6	0.0	0.0	0.0	0.0	0.0	69.6	0.0	0.0	0.0	69.6	0.0	69.6
TOTAL	358.3	299.7	115.3	0.0	0.0	0.0	450.0	773.3	2,669.5	0.0	450.0	773.3	3,119.5	-2,346.2
QDPI														
SALARIES	14.7	12.6	13.7	0.0	0.0	0.0	130.0	41.0	771.6	0.0	130.0	41.0	901.6	-860.6
OTHER	34.3	29.3	36.3	0.0	0.0	0.0	280.0	99.9	1,683.5	0.0	280.0	99.9	1,963.5	-1,863.6
OTHER CONTRIBUTIONS	0.0	112.2	98.7	0.0	0.0	0.0	0.0	210.9	0.0	0.0	0.0	210.9	0.0	210.9
TOTAL	49.0	154.1	148.7	0.0	0.0	0.0	410.0	351.8	2,455.1	0.0	410.0	351.8	2,865.1	-2,513.3

Table 9: In Kind Contributions continued

	ACTUAL							CUMULATIVE				GRAND TOTAL		
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2006/07	TOTAL TO DATE		2007/08	2007/08	Total	Agr'mt	Diff
	Actual	Actual	Actual	Actual	Actual	Actual	Agr'mt	Actual	Agr'mt	Budget	Agr'mt	7 Yrs	7 Yrs	7 Yrs
SARDI														
SALARIES	89.5	69.1	93.4	40.4	67.5	21.4	150.0	381.3	882.4	28.1	150.0	409.4	1,032.4	-623.0
OTHER	143.2	110.6	149.4	87.7	144.6	54.0	225.0	689.5	1,414.9	50.8	225.0	740.3	1,639.9	-899.6
OTHER CONTRIBUTIONS	108.5	187.3	0.0	0.0	153.6	217.6	0.0	667.0	0.0	49.1	0.0	716.1	0.0	716.1
TOTAL	341.2	367.0	242.8	128.1	365.7	293.0	375.0	1,737.8	2,297.3	128.0	375.0	1,865.8	2,672.3	-806.5
USDA														
SALARIES	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	271.1	0.0	50.0	0.0	321.1	-321.1
OTHER	0.0	0.0	0.0	0.0	0.0	0.0	75.0	0.0	400.2	0.0	75.0	0.0	475.2	-475.2
OTHER CONTRIBUTIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	125.0	0.0	671.3	0.0	125.0	0.0	796.3	-796.3
VALIGEN														
SALARIES	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	262.0	0.0	50.0	0.0	312.0	-312.0
OTHER	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	514.4	0.0	100.0	0.0	614.4	-614.4
OTHER CONTRIBUTIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	150.0	0.0	776.4	0.0	150.0	0.0	926.4	-926.4
VIDA														
SALARIES	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	56.1	0.0	10.0	0.0	66.1	-66.1
OTHER	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	78.6	0.0	15.0	0.0	93.6	-93.6
OTHER CONTRIBUTIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	134.7	0.0	25.0	0.0	159.7	-159.7
TOTAL SUPPORTING IN-KIND CONTRIBUTIONS														
SALARIES	294.6	241.0	212.2	98.3	117.8	34.8	695.0	998.7	4,031.8	38.2	695.0	1,036.8	4,726.8	-3,690.0
OTHER	482.0	398.4	350.2	220.1	258.5	84.3	1,136.3	1,793.5	6,707.4	70.1	1,136.3	1,863.6	7,843.7	-5,980.1
OTHER CONTRIBUTIONS	223.2	649.3	586.8	779.1	307.5	428.9	0.7	2,974.9	3.5	123.2	0.7	3,098.1	4.2	3,093.9
TOTAL (IN-KIND)	999.8	1,288.7	1,149.2	1,097.5	683.8	548.0	1,832.0	5,767.0	10,742.7	231.5	1,832.0	5,998.5	12,574.7	-6,576.2
TOTAL IN-KIND CONTRIBUTIONS (CORE & SUPPORTING)														
SALARIES	1,388.1	1,268.1	1,341.5	891.3	951.1	856.9	1,820.0	6,697.0	10,809.6	602.8	1,820.0	7,299.8	12,629.6	-5,329.8
OTHER	2,212.3	2,143.0	2,201.9	2,249.6	2,550.1	2,363.9	2,897.7	13,720.8	18,955.2	1,349.6	2,897.7	15,070.4	21,852.9	-6,782.5
OTHER CONTRIBUTIONS	1,892.7	3,947.8	4,392.1	4,379.7	3,535.4	2,259.4	1,684.3	20,407.1	8,493.1	2,069.1	1,684.3	22,476.2	10,177.4	12,298.8
GRAND TOTAL (IN-KIND) (T1)	5,493.1	7,358.9	7,935.4	7,520.6	7,036.5	5,480.2	6,402.0	40,824.8	38,257.9	4,021.5	6,402.0	44,846.3	44,659.9	186.4

Table 10: Summary of resources applied to activities of the CRC

	ACTUAL						CUMULATIVE					GRAND TOTAL		
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2006/07	TOTAL TO DATE		2007/08	2007/08	Total	Agr'mt	Diff.
	Actual	Actual	Actual	Actual	Actual	Actual	Agr'mt	Actual	Agr'mt	Budget	Agr'mt	7 Yrs	7 Yrs	7 Yrs
RESOURCES APPLIED TO ACTIVITIES OF THE CENTRE														
TOTAL IN-KIND CONTRIBUTIONS - Table 1	5,493.1	7,358.9	7,935.4	7,520.6	7,036.5	5,480.2	6,402.0	40,824.8	38,257.9	4,021.5	6,402.0	44,846.3	44,659.9	186.4
TOTAL CASH CONTRIBUTIONS -Table 2	4,660.5	5,771.0	6,089.2	5,365.0	5,310.0	4,553.1	4,541.0	31,748.8	31,565.0	3,198.7	4,286.0	34,947.5	35,851.0	-903.5
TOTAL RESOURCES APPLIED TO ACTIVITIES OF THE CENTRE														
	10,153.6	13,130.0	14,024.6	12,885.6	12,346.5	10,033.3	10,943.0	72,573.6	69,822.9	7,220.2	10,688.0	79,793.8	80,510.9	-717.1
ALLOCATION OF TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE BETWEEN HEADS OF EXPENDITURE														
TOTAL CASH & IN-KIND SALARIES	3,864.8	4,099.7	4,863.2	4,242.1	4,484.3	4,055.3	4,820.0	25,609.3	31,174.6	3,476.0	4,640.0	29,085.4	35,814.6	-6,729.2
TOTAL CASH & IN-KIND CAPITAL	95.3	55.3	406.7	174.9	99.7	62.0	0.0	893.9	142.0	0.0	0.0	893.9	142.0	751.9
TOTAL CASH & IN-KIND OTHER	5,504.7	8,526.7	8,644.6	8,579.9	7,822.5	6,129.9	6,123.0	45,208.4	38,506.3	4,841.9	6,048.0	50,050.3	44,554.3	5,496.0
TOTAL (All Resources)	**9,464.8**	**12,681.8**	**13,914.4**	**12,996.9**	**12,406.5**	**10,247.2**	**10,943.0**	**71,711.7**	**69,822.9**	**8,317.9**	**10,688.0**	**80,029.6**	**80,510.9**	**-481.3**

Table 11: Allocation of resources between categories of activities

PROGRAMME	RESOURCE USAGE			
	$ Amount		Person Years	
	$ CASH (1)	$ In-Kind	Staff (In-Kind) Contributed	Staff Funded by CRC
Research	4,081.0	4,752.2	9.1	42.9
Education	416.8	518.9	1.0	4.3
External Communications	0.0	0.0		
Commercialisation / Tech Transfer	120.9	0.0	0.0	0.5
Administration	751.3	209.1	0.4	3.2
TOTAL	**5,370.0**	**5,480.2**	**10.5**	**50.8**

FINANCIAL REPORT ON THE COMPANY

In accordance with a resolution of the directors of Value Added Wheat CRC Limited, we state that: In the opinion of the directors:

(a) the financial statements and notes of the company and the consolidated entity are in accordance with the Corporations Act 2001, including:

  (i) giving a true and fair view of the company's and consolidated entity's financial position as at 30 June 2007 and their performance for the year ended on that date; and

  (ii) complying with Accounting Standards and Corporations Regulations; and

(b) there are reasonable grounds to believe that the company will be able to pay its debts as and when they become due and payable.

On behalf of the Board

Peter Vaughan

Managing Director

Sydney, 13th September 2007

WHK Horwath

INDEPENDENT AUDIT REPORT
TO THE MEMBERS OF
VALUE ADDED WHEAT CRC PTY LIMITED

Report on the Financial Report

We have audited the accompanying financial report of Value Added Wheat CRC Limited (the Company), which comprises the balance sheet as at 30 June 2007 and the income statement, statement of changes in equity and cash flow statement for the year ended on that date, a summary of significant accounting policies and other explanatory notes and the Directors' declaration.

Directors' Responsibility for the Financial Report

The Directors of the Company are responsible for the preparation and fair presentation of the financial report in accordance with Australian Accounting Standards (including the Australian Accounting Interpretations) and the Corporations Act 2001. This responsibility includes establishing and maintaining internal control relevant to the preparation and fair presentation of the financial report that is free from material misstatement, whether due to fraud or error; selecting and applying appropriate accounting policies; and making accounting estimates that are reasonable in the circumstances.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial report based on our audit. We conducted our audit in accordance with Australian Auditing Standards. These Auditing Standards require that we comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance whether the financial report is free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial report. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial report, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the Company's preparation and fair presentation of the financial report in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Company's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by the Directors, as well as evaluating the overall presentation of the financial report.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Independence

In conducting our audit, we have complied with the independence requirements of the Corporations Act 2001.

Auditor's Opinion

In our opinion:

a. the financial report of Value Added Wheat CRC Limited is in accordance with the Corporations Act 2001, including:

   i. giving a true and fair view of the Company's financial position as at 30 June 2007 and of their performance for the year ended on that date; and

   ii. complying with Australian Accounting Standards (including the Australian Accounting Interpretations) and the Corporations Regulations 2001.

Continuation as a Going Concern

Without qualifying our opinion, we draw attention to Note 15 in the financial report which indicates that Value Added Wheat CRC Limited is in its final year of operations. As a result Value Added Wheat CRC Limited's is not a going concern.

WHK Horwath

WHK HORWATH

DAVID SINCLAIR
PRINCIPAL

Dated at Sydney this 11th day of September 2007.

LIST OF TABLES

GLOSSARY OF TERMS

TERM	MEANING		TERM	MEANING
Ab	Antibody		**MAP**	Modified-atmosphere packaging
ABB	Former Australian Barley Board		**MD**	Managing Director
ACIP	Advisory Council on Intellectual Property		**MIA**	Murray Irrigation Area
ACPFG	Australian Centre for Plant Functional Genomics		**min**	Minutes
AFLP	Amplified fragment length polymorphism		**Null-4A**	4A gene absent/non-functional
AGI	Austgrains International		**NVT**	National variety trials
AGT	Australian Grain Technologies		**P**	Probability
AWB	Former Australian Wheat Board		**PAGE**	Polyacrylamide gel electrophoresis
CAMBIA	Center for the Application of Molecular Biology to International Agriculture		**PBR**	Plant Breeder's Rights
CD	Compact disc		**PCR**	Polymerase chain reaction
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Centre)		**PCT**	Patent Cooperation Treaty patent
CO2	Carbon dioxide		**PDT**	Physical dough testing
DAFWA	Dept of Agriculture and Food, Western Australia		**pI**	Isoelectric point
DArT®	Diversity Arrays Technology®		**Pin**	Puroindoline
DArTSoft	Proprietary software of DArT P/L		**PPO**	Polyphenol oxidase
DH	Doubled Haploid		**PQV**	Protein quality value
DNA	Deoxyribonucleic Acid		**QA**	Quality assurance
DPI	Department of Primary Industries		**QDPI&F**	Department of Primary Industries & Fisheries, Queensland
DTT	Dithiothreitol		**QTL**	Quantitative trait locus/loci
EGA	Enterprise Grains Australia		**R & D**	Research and development
ELISA	Enzyme-Linked Immunosorbent Assay		**RACI-CCD**	Royal Australian Chemical Institute - Cereal Chemistry Division
EMAI	Elizabeth Macarthur Agricultural Institute		**RFLP**	Restriction fragment length polymorphism
EMS	Ethyl-methyl sulphonate		**SARDI**	South Australian Research and Development Institute
Fc	Constant fragment (domain) of an antibody		**S&D**	Sponge and dough
FIG	Food Innovation Grant		**SIG**	Swelling index of glutenin
FSV	Flour swelling volume		**SME**	Small-Medium Enterprise
GBSS	Granule-bound starch synthase		**SMG**	Senior Management Group
GI	Glycaemic index		**SNP**	Single nucleotide polymorphism
Glu-D1 (etc)	Glutenin DI allele (etc)		**SSP**	Starch swelling power
GRDC	Grains Research and Development Corporation		**SSR**	Simple sequence repeat
ICIS	International Crop Information System		**STB**	*Septoria tritici* blotch
IRRI	International Rice Research Institute		**STM**	Sequence-tagged microsatelite
IWIS	International Wheat Information System		**STS**	Sequence-tagged site
IP	Intellectual Property		**SWIP**	Speciality Wheat Improvement Program
1B/1R	Rye/wheat chromosomal translocation		**TA-XT2**	Texture analyser
IT	Information Technology		**TILLING**	Targeting Induced Local Lesions in Genomes
LF	Long fermentation		**UQ**	University of Queensland
LMA	Late-maturity alpha amylase		**VAWCRC**	Value Added Wheat CRC
LOX	Lipoxygenase		**YAN**	Yellow alkaline noodles
Mab	Monoclonal antibody		**XRD**	X-ray diffraction

Value Added Wheat CRC Limited

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