Rural Research and Development Corporation Chairs Committee Submission

The House of Representatives

Standing Committee on Science and

Innovation

Inquiry into pathways to technological innovation, related issues and examples of successful innovations

April/May 2005

Dr Anna Dacre

Secretary,

29 April 2005

Standing Committee on Science and Innovation
Parliament House,
CANBERRA ACT 2600
scin.reps@aph.gov.au

Dear Dr Dacre,

Re: House of Representatives Standing Committee on Science and Innovation Inquiry into Pathways to Technological Innovation

Thank you for your letter of 23 March 2005 advising of the above Inquiry and seeking the views of the Rural R&D Chairs Committee to it.

The Australian innovation system undoubtedly has excellent attributes in its institutional structures, funding, policy and program frameworks, scientific and technology skills and capabilities, and in high performance elements of the commercial system. The Committee has before it the challenge to investigate and advise on ways to make the system operate more effectively, particularly in unlocking the potential for better commercial outcomes.

Rural Research and Development Corporations (RDCs) have achieved success in these areas through the scope provided by their unique co-investment arrangements with their principal Australian Government, rural industry, and other stakeholders. The 'RDC model' has equipped them to effectively network and navigate their way through the complexities of Australia's pluralistic system. They do this particularly through their:

- Strategic management focus and processes, so enabling agreement with stakeholders on priorities for development and uptake of world's best practice technologies;
- Corporation status, enabling them to network across the entire innovation system with government, public research organizations and commercial market participants; and
- Capacities to leverage Government matched industry funding with partner contributions to build sound portfolios of R&D investments and collaboration with partners to drive industry global competitiveness.

While their immediate focus may be on facilitating high rates of adoption and uptake of research, RDCs remain alert to commercial opportunities and the ultimate aim of maximising commercial returns to benefit their rural industry constituents and the nation. Four examples of RDC success are highlighted here to illustrate the way they operate and provide benefit.

The first example is the unique success of the cotton industry in developing and gaining acceptance for the introduction of genetically modified cotton. The Cotton RDC (CRDC) was well placed to facilitate this achievement in light of the strength of their relationships and

networking capabilities and their strategic focus on high level innovation outcomes. This success was linked to the CSIRO development of premium cotton varieties, again with a key facilitation role by CRDC. This enabled the Australian Cotton industry to become world's best practice leaders and to deliver strong royalty flows from commercial exploitation of the use of their innovative varieties by producers in other nations.

The second example is the rice industry success in the development and uptake of electro magnetic technologies for detection of leaky soils as a basis for locating rice production where water use efficiencies can be optimised. The universal adoption of this innovative technology has increased commercial returns throughout the industry and associated rural and regional communities. It has also spawned new companies to service industry requirements in harnessing the new innovative technology.

A third example is the development of Beef quality gene markers facilitated by Meat and Livestock Australia and its innovation and commercial partners. It enables selection and breeding of cattle with meat quality traits that meet specific market needs. This provides the industry with the scope to increase the rate of genetic improvement in herds and flocks, to select animals to go into specialised production systems and to efficiently produce quality meat tailored to meet consumer requirements.

The final example is the generic case of new industry development and transformation of existing industries. Canola, Noodle and Durum Wheat, Olive and Rabbit Meat, industries are prime instances. The Australian Wine industry has, since the RDC type arrangements were put in place 20 years ago, been transformed from a total exporter of less than $10 million pa to the present level of above $2.5 billion pa.

The 'RDC model' itself and the individual RDCs are also examples of Australian technological solutions to meet national difficulties and circumstances and to build on critical factors for success. They have been successful because of their well developed innovation cultures, close symbiotic stakeholder relationships and flexibility from their corporate status.

While RDCs have always been industry driven and market responsive they are increasingly focused on commercial outcomes, in light of the more proactive involvement of their commercial partners and their government, industry, research and community stakeholders. The development of six industry-owned company RDCs which merge R&D, marketing and promotion functions, has been an important step in this process.

This submission is provided on behalf of the 14 corporations, although some RDCs will also provide separate individual RDCs submissions. Should you wish to raise any issues on the submission the appropriate contact in the first instance is Alan Newton on (02) 6272 3499 or 040 843 1932.

I commend the submission to you.

Yours sincerely,

Terry Enright, Chair, Rural R&D Corporation Chairs Committee

INTRODUCTION

Terms of reference

Our understanding of the terms of reference is that the Committee has been tasked by the Minister, to inquire into and report on Australian technological innovations and their pathways to commercialisation, including an examination of strategies to overcome potential barriers and factors which determine innovation success.

The inquiry will address a number of specific issues identified in the Committee's documentation and the Committee will seek to compile a series of case studies of successful technological innovations, and the pathways to commercialisation.

Specific issues identified for comment

Issues mentioned by the Committee for comment are:

- pathways to commercialisation;
- intellectual property and patents;
- skills and business knowledge;
- capital and risk investment;
- business and scientific regulatory issues;
- research and market linkages;
- factors determining success; and
- strategies in other countries that may be of instruction to Australia.

Meaning and measurement of 'commercialisation'

For an understanding of these issues and as a basis for discussion, this submission draws on the Final Report to the 15 April 2005 54th Meeting of the Coordination Committee on Science and Technology, of The Muir Committee 'Metrics for Research Commercialisation'.

The 'Muir' report proposed, inter alia, a broader definition for research 'commercialisation' for publicly funded research. This is, 'the means by which universities and publicly funded research agency research generate commercial benefit, thereby contributing to Australia's economic, social and environmental well-being. This is achieved through developing intellectual property (IP), ideas, know-how and research-based skills resulting in new and improved products, services and business processes transferable to the private sector.'

The 'Muir' report also proposed a set of 14 metrics covering IP, contacts and consultancies, and skills development and transfer for adoption as the basis for future data collection and assessment relating to research commercialisation across Australia's publicly funded research organisations.

Background to the Rural R&D Corporations

The Rural R&D Corporations (RDCs) operate within the Australian Government Department of Agriculture, Fisheries and Forestry, portfolio in accordance with administrative arrangements and requirements which are primarily set out in either the Primary Industries and Energy Research and Development Act 1989, or separate company legislation in the case of industry owned companies.

A comprehensive guide to the underlying policy framework for RDCs is provided by the Government May 1989 'Research Innovation and Competitiveness' Statement on Policies for Reshaping Australia's Primary Industries and Energy Portfolio Research and Development.

Examples of successful innovations

The RDC model is in itself a highly successful example of Australian technological innovation that has a strong track record of accomplishment in demonstrating strategies to overcome potential impediments and factors determining success.

Through their focus on the adoption and utilisation of research, including through commercialisation as a major pathway, RDCs have contributed to the establishment of strong foundations for commercial performance by their industries and include policies and processes for exploiting opportunities for commercialisation of research where appropriate.

Examples from RDC investments where commercialisation of research has been successfully pursued are highlighted in the submission.

Structure of this submission

This introduction is followed in section 1 of the submission by a more detailed outline of the key features and benefits of the Rural R&D Corporation framework arrangements, or so called 'RDC model'.

This is followed in section 2 by comments, with particular reference to successful innovations, on the specific issues raised by the Committee in its letter of invitation.

Details of successful Australian technological innovations from RDCs that demonstrate strategies as specified by the Committee are provided at section 3.

A number of conclusions from the Rural Research and Development Corporations related to the work of the Committee are included in section 4.

Section 1: THE RURAL R&D CORPORATION FRAMEWORK ARRANGEMENTS

Key Features

Achievements under the 'RDC model' make it an important example of a successful Australian pathway to technological innovation. The model was established to provide an industry driven and market responsive programme of investment in R&D to ensure Australian rural producer access to the leading edge technologies that they need to enable them to be globally competitive. It consists of 14 organisations including eight statutory corporations, for cotton, fisheries, forest and wood product, grains, grape and wine, land and water, rural industries and sugar. It also includes six industry owned companies combining R&D with industry marketing/ promotion functions, for dairy, eggs, horticulture, pork, meat and livestock, and wool.

The 14 RDCs and information on their incomes and expenditures for the 2003/04 financial year, including the relative contributions from industry and the Australian Government, are set out in Attachment A to this submission.

All RDCs (except the Australian Egg Corporation Limited), has a Board of nine Directors (including the CEO), and operate under standard provisions, prescribed in legislation, for selection and appointment of Boards, strategic management, and accountability over performance. Their day-to-day focus is on the management of their R&D strategic investment portfolios on behalf of their industries and the Australian government, particularly the allocation and administration of funds to research partners. RDCs do not conduct research.

The need for such a framework arises from the inherent tendency in rural industries, for under-investment in R&D and includes measures to overcome this.

The problem of probable under-investment in rural R&D arises from the nature of rural product markets and the preponderance of a very large number of small producers each with little market power. Consequently, individual producers are unlikely to have the incentive to invest in R&D. Producers who do invest are unlikely to be able to fully appropriate the benefits from so doing, while those who do not invest will, nonetheless, probably be able to gain access to the ensuing innovative technologies. This situation unless addressed, has the potential to result in a significant loss of benefit to individual producers, rural and associated industries, and the nation. It has long been accepted that there is a strong case for government intervention to overcome this market failure and to ensure that the appropriate level of investment in rural R&D is conducted, leading to higher levels of technological innovation.

Benefits

The RDC framework has successfully addressed the problem of under-investment in rural R&D and the ensuing level of technological innovation, through development of a strong rural and associated industry innovation culture, which pervades a whole set of productive stakeholder relationships across the entire supply chain and through rural and regional communities. This has been achieved through a number of processes, including:

- Government facilitation of RDC framework arrangements through the provision of enabling legislation, including, compulsory levies, with the agreement of producers, and R&D co-investment with rural industries and their research partners;

- Strategic management processes which act to overcome market imperfections, including the establishment of RDCs as corporate entities, legislative mandates requiring compliance with certain management, accountability and reporting procedures, and operation in line with corporate commercial behaviour;

- Direct involvement of rural producers, linked to their various stakeholder groups, in decision making on industry R&D programmes. This leads to greater awareness and understanding of R&D and its value, and the commitment for investment and other essential inputs through the supply chain at the levels required for attainment of global competitiveness;

- The inclusion of Government National Research Priorities in RDC priority setting and strategic planning processes to ensure that these are satisfactory aligned, so enabling the integration of public and private rural R&D investment outcomes.

- High rates of adoption, utilisation and commercialisation of research as a product of the strong user driven focus of RDCs and the close symbiotic relationship between producers, their industry, government and research stakeholders and the direct and indirect benefits which come from wider linkages with other stakeholders across the entire supply chain;

- The devolvement of considerable flexibility to RDCs over the management of their R&D investments, which enables them to invest beyond the applied focus that is often perceived to be their key area of concern. RDCs may be viewed more broadly as custodians tasked with ensuring that their industries have the future access to leading edge innovative technologies they need to be globally competitive and to fulfil their other objectives. If their strategic analysis indicates that investment is required, for example in areas of fundamental or "blue sky" research, then they can and do make the investment. In a similar vein RDCs remain alert at all times to commercialisation opportunities and enhancing commercial returns to their industries, where and if appropriate, is core business for them.

As a result of the inherent advantages of their model, on the basis of a number of objective analyses, RDCs have been shown to achieve average 7:1 benefit to cost ratios from their investments in research. They also enjoy high levels of contribution from their government and industry stakeholders enabling a combined annual R&D investment of over $464m. When research partner contributions are added this means that the total value of the R&D portfolio managed by all RDCs at any one time is around $1 billion.

To illustrate the growth in business investment in innovation which has been achieved under the model, in the period between 1984/85, (the last year of previous arrangements) and 2003/04, the annual level of investment by RDCs increased from $63m to the current $464m. The respective contributions increased over that time from $26.5m to over $222m for industry and from $39.9m to over $204m for the Commonwealth.

In the process, Australian producers have become world's best practice innovators through all aspects of the supply chain from breaking down trade barriers at one end to on-farm efficiency and sustainable production at the other. This has assisted in containing impacts from the long term decline in their terms of trade, and enabled high pay-offs to be delivered for rural and related industries, rural communities and the nation.

In addition to the strengths drawn from the industry specific focus of each RDC, corporations work collaboratively, when it is beneficial to do so, in funding programs of joint interest and in information sharing and collaboration in the development of administrative systems and

processes. RDCs also have in place a Chair of Chairs Office and Secretariat to serve as a conduit for two-way communication with Government on significant policy matters affecting all corporations. This mechanism may also be used to handle other items business on behalf of all RDCs where considered to be appropriate.

A study of RDCs prepared in August 2003 by the Centre for International Economics for the Science and Innovation Mapping conducted through the Department of Education, Science and Training - 'The Rural Research and Development Corporations: *A case study for innovation*', is attached to the email submission for reference by the Committee.

Section 2: COMMENT ON THE SPECIFIC ISSUES RAISED BY THE COMMITTEE

Pathways to commercialisation

The strategic focus of RDCs is normally, in the first instance, on the achievement of high levels of adoption and utilisation of research with consideration of commercialisation pathways as one of the options for achieving success in these areas. High levels of adoption and utilisation are derived by having R&D "products" that are strongly focussed on user needs, developed closely with users and "extended" through the most appropriate pathway. This process is directed at ensuring strong industry ownership and market pull for R&D outcomes and is likely in many cases to involve commercialisation.

The focus on adoption and utilisation of research, results from the nature of rural product markets and related market failure issues discussed above, and the consequent need to keep enabling producers to be strategically placed at the frontiers of technological innovation and global competitiveness. In many instances research is directed at problems unique to Australia and/or the size of the Australian market dictates a limit to commercialisation opportunities.

Additionally there is a view that producers, where they are the main target for adoption of a new technology, have in effect already contributed to the products from research and should not be required to make further payment. This is in recognition of the contribution they make through compulsory levies and the benefits they receive from government matching contributions, which in part, are perceived as an alternative to government incentives to businesses in other sectors, such as through 125% tax deductibility.

As an indication of their normal strategic intent, in many past cases where RDCs have developed new technologies in collaboration with a public or private partner, their entitlements to the intellectual property involved, and or a share of licence and royalty payments, have been used to secure agreement that the technology is made freely available to Australian industry constituents of the RDC.

While RDCs may choose to not to pursue pathways to commercialisation in the first instance with much of their research, they remain alert to commercialisation opportunities, and where this presents the best outcome then it will be pursued. For example when RDCs are dealing with commercial partners, the commercial pathway may well be the best way to ensure producer access to the technology. It may also be relevant in cases where Australian innovative technologies are adopted by competitor producers in overseas countries. Commercialisation in such instances may enable some control over that use, development of robust international partnerships, and for income streams so derived to be applied to the benefit of Australian producers. The development of premium cotton varieties under a partnership between CSIRO, Cotton RDC and other industry players is such an example.

RDCs have in place specific commercialisation policies, structures and processes to facilitate the take up the commercial opportunities which arise from their R&D activities. They also establish through their activities a number of pre-conditions to the successful commercialisation of research, through for example, their investments in new product and industry development, transformation of existing industries (with wine as the best example), human resource management, (including GRDC funding of the Australian Centre for Intellectual Property in Agriculture at ANU), in environmental sustainability, rural and

regional development, and in new frontier technologies (for example GRDC funding of the Plant Functional Genomics Centre at the Waite Institute).

Additionally it should be noted that the ultimate aim of RDCs is commercial, in that their overall role is to enhance commercial returns to their producers and the community. As an example the grains industry has enjoyed annual productivity gains of between 2.5 and 3% over the 20 years of operation under RDC model type arrangements, with more than half of that gain coming from returns from industry R&D investments.

The Primary Industries and Energy Research and Development Act 1989, which governs the operations of the eight statutory RDCs mentioned above, also prescribes objects for RDCs, which are to:

- Increase the economic, environmental or social benefits to producers and the community;
- Achieve sustainable use and management of natural resources;
- Make more effective use of the resources and skills of the community and the scientific community; and
- Improve accountability for expenditure on primary industry R&D.

The approach taken by RDCs to commercialisation is well illustrated by the following comments from Meat and Livestock Australia (MLA):

"From an MLA perspective, each project outcome is reviewed individually to determine the most appropriate and efficient path to adoption. Commercialisation is one of the options available to us to manage this process. Commercialisation enables us to maintain a level of control by agreeing to levels of market penetration with a commercialiser and using these performance criteria to ensure adoption by industry. By retaining an interest in these outcomes through IP ownership and/or commercialisation agreements, MLA can also legitimately work closely with the commercialiser to support adoption by the industry. If a commercialiser fails to perform to the agreed performance criteria, a well established commercialisation agreement can also enable the RDC to "claw back" rights to project outcomes and reassign these to another commercialiser (VIAscan is a recent and relevant example of this for MLA).

Another important value-add by RDCs in the commercialisation of technologies is that the commercialised outcome usually arises from a larger program of work. As a result the commercialisation of the individual technology is often only one component of a suite of broader industry adoption activities for the entire program. For example the Genetic Solutions commercialisation is supported by the broader education and dissemination activities that MLA is undertaking in genetics and meat quality. Similarly, the Meat Electronics technologies are supported by broader adoption activities in educating the processing industry on the benefits of stimulation and meat eating quality.

As a broader comment regarding commercialisation pathways, it must also be kept in mind that IP ownership is a separate issue to the rights and performance criteria that we agree to in our commercialisation arrangements".

With regard to their adoption focus, the 14 RDCs have agreed to combine in an examination of the scope for improved measurement of the level of uptake and adoption of research as a basis for reporting to their principal government and industry stakeholders. As a starting point for examination in this area they have prepared a snapshot of past RDC successes and future adoption targets as a guide to future developments in this area.

A Copy of the report, 'Technology Adoption in Rural Industries: A Snapshot of Past Successes and Future Targets,' is attached to the email transmission of this submission for the Committee's reference.

On the appropriateness of commercialisation as a primary driver for Australian research, wider account needs to be taken on issues about the size and nature of Australian product markets and the focus, composition and structure of our industries compared to those in other countries. These clearly have relevance for the applicability to Australian circumstances of commercialisation of research as a primary objective and to the way it is targeted and its outcomes measured.

Intellectual property and patents

RDCs have individual policies on intellectual property and commercialisation matters including on patents. Generally this involves them taking a position on intellectual property ownership on behalf of their industries but may also involve special arrangements to ensure that wider industry requirements such as high rates and early uptake of new technologies. As well, all RDCs operate in an environment where the question of freedom to operate and deliver outcomes for their respective industries demands a clear understanding of the rigour needed in the management of intellectual property. They have shared this responsibility with a wide range of public and private research partners who also operate in this environment.

GRDC investment in the Australian Centre for Intellectual Property in Agriculture at the Australian National University is a vehicle for enhancing RDC policies in this area.

RDCs are generally flexible in their approach on how they deal with intellectual property and patents and look for the option that will deliver the best path to adoption and may in some cases opt for providing open access to materials.

Skills and business knowledge

Through their investment of over $35m annually in human resource development RDCs also make a substantial contribution to the development of national capacities and capabilities to both develop and utilise world's best practice technological innovations. This is achieved through support for graduate, post graduate and post doctoral study, overseas visits to and from Australia, Rural Leadership, Industry Development, Joint RDC Capabilities Development to enhance innovation reception and adoption of technological innovations.

Specific examples include:

- Investment in the establishment of the Australian Centre for Intellectual Property in Agriculture at the Australian National University;
- RIRDC investment in the Rural Women's leadership program with support from the Australian Women's Weekly, Rural Press, the ABC and other sponsors. This award is designed to recognise and encourage the vital contribution women make to rural Australia;
- Industry leadership courses such as the Advance in Seafood Leadership Course, which is run all over the country.

Investment in human resource development has over time enabled the substantial development of human resource capabilities across the nation in support of the activities

and outcomes of RDCs. Included in this are high rates of adoption, utilisation and commercialisation of research and overall performance of RDCs on commercial and other assessment criteria.

Capital and risk investment

RDCs work in close collaboration with their principal stakeholders and research and commercial partners in fashioning an appropriate portfolio of R&D investments and in managing the attendant exposure to risk. As expected this is a demanding assignment. On one hand they must act in accordance with the strictures and processes of government, on the other they must respond to strong calls from their industries for guidance on bold future strategies to drive commercial success, but with sufficient conservatism to avoid undue exposure to risk. At the same time they must keep an eye on commercial markets to determine feasible and prospective strategies to deliver a balance on risk and return probabilities, while simultaneously aligning their strategies to the capacities and profiles of their research and commercial partners.

The processes sketched above are difficult and complex to manage. They are nonetheless central to the operation of contemporary global markets and to the development of winning strategies in the harsh prevailing circumstances which prevail. And they depict the environment which must be confronted and which RDCs are uniquely equipped to do effectively. In particular, RDCs are well suited to operate in a pluralistic environment.

In looking to ways to appropriately manage risk RDCs employ a number of approaches. They are likely to seek commercial partners where the level of risk exposure and expertise requirements may be greater and generally do not incline to 'pure' research projects, which are likely to have a higher risk/return profile and to typically be funded by government and universities. They are also very aware of the governance issues which may be associated with funding of higher risk projects and have devoted considerable attention to developing appropriate structures and processes for effectively managing in these circumstances.

RDCs are not involved in raising capital but as part of sound business management practices many require business case analyses, similar to a venture capital proposal, as a pre-requisite to pursuing investment in R&D commercialisation. Similarly such analyses include risk assessment of the probabilities and consequences of success and failure.

Significant capital investment is required when commercialisation is the preferred adoption pathway. The degree and form of control RDCs seek to retain over the process varies between organisations and individual research projects. Risk assessment and its management form an integral component in the decision making process. However, there is general recognition that commercialising partners not only bring additional capital but also the necessary expertise and resources to the investment. A number of RDCs have successfully entered into collaborative commercialisation arrangements where it has been determined to be the most appropriate adoption pathway. For example, Cotton RDC receives royalty streams from cotton varieties developed by research provider CSIRO and marketed by a commercialising partner, Cotton Seed Distributors.

It is also important to note that without the RDC Investment a large number of projects would not have ordinarily been undertaken due to the associated risk. While the major part

of RDC R&D is not 'blue sky' there is still a strategic need for some R&D in this category to be undertaken.

Business and scientific regulatory issues

RDC legislation establishes an operating environment with clear guidelines on corporate governance and business activity. RDCs recognise and support the need for sound scientific regulatory policies and procedures.

All Australian primary production enters world trade in a range from relatively unprocessed products through to finished consumer products. Australia is the beneficiary of the billions of dollars of foreign currency that this trade represents. To be in those markets makes very high demands on understanding the business and regulatory pressures in a great many countries. RDCs have variable investments in market development and understanding, often to provide a robust base from which policy arguments can develop. Additionally all RDCs share the recognition of quality assurance and food safety requirements that are an inherent part of trading in consumer products. Sometimes matters of regulation and quality assurance tend to merge and the need to provide a sound research base to limit the impacts of potential technical barriers to trade. The RDCs frequently share objectives in these areas and cooperate closely with state and Commonwealth agencies on matters ranging from quarantine to food safety.

As major supporters of plant breeding research in Australia, which includes the application of biotechnology and gene technology, RDCs are presented with a number of challenges regarding the potential to commercially exploit innovative technologies for industry benefit. These include appropriately addressing community and consumer attitudes, regulatory constraints, and the present moratoria on the commercial release of genetically modified (GM) food crops.

The existing moratoria and the possibility of repeated extension on review every five years creates regulatory uncertainty, raise doubts about the commitment of State Governments to biotechnology research, and also raise doubts about the likelihood of a market being available in any Australian State or Territory for the end-products of gene technology research such as that supported by RDCs.

As RDCs recognise the importance of developing products and markets in parallel with scientific developments, the decision-making process for continued investment in gene technology R&D would need to take into account the possibility that there may not be a clear pathway to market for products derived from that research. Such regulatory uncertainty could ultimately make RDCs and other funding bodies seeking a return on their investments for their constituents increasingly reluctant to continue investing in gene technology research in the future.

While community concerns about gene technology should not be ignored, an option for consideration is for the State and the Commonwealth to support national legislation on gene technology matters and to allow a body such as the Office of the Gene Technology Regulator (OGTR) to take a lead role in coordination. At present the moratoria pre-empt the risk assessment process undertaken by the OGTR.

This is nonetheless likely to remain an important issue that will impact investment decisions by the RDCs and other R&D organisations in the foreseeable future.

The *Primary Industries and Energy and Development (PIERD) Act 1989* and *Commonwealth Authorities and Companies (CAC) Act 1997* Finance Minister's Orders and Australian Accounting Standards and Accounting Interpretations provide the accountability and reporting framework for RDCs. This framework improves accountability for expenditure on research and development activities in relation to primary industries. RDCs also recognise and support the need for sound scientific regulatory policies and procedures.

Research and market linkages

This is an area of particular strength from RDC framework arrangements. It in particular, enables significant leveraging of available RDC funding investment and achievement of high rates of research adoption and utilisation.

The key here is that RDCs continually network with their stakeholders, including their research partners, their industry and associated industries, other players through the supply chain, and those in rural and regional communities. This is particularly the case with RDC periodic priority setting, strategic planning reporting and accountability processes. As a result RDCs remain closely linked to the strategic imperatives of their stakeholders and to prevailing realities of the marketplace. They also directly invest in strengthening industry and research capabilities to operate at high levels of performance and in a wide range of strategic research on behalf of industry.

The development of six industry owned companies in key industries, which merge the R&D, industry marketing and promotion functions, is an example of approaches to enhance the focus of RDCs focus on market responsive R&D and encourage an holistic view of industry operations and whole of chain linkages. This may take RDCs through the whole spectrum of industry activities from genetic development of new varieties or livestock characteristics, through efficient and sustainable on-farm production, through the marketing, processing, storage, handling and distribution elements of the chain and include negotiation of market access, trade and bio-security issues.

An example is development by the meat industry of gene markers for tenderness which enables them to select the genetic characteristics for herd development and to take this through the whole raft of commercial processes to presentation of a steak of an appropriate and prescribed level of tenderness to the ultimate consumer. Other examples include the MLA's Partners in Innovation, and Plant Initiated Projects programs, and Horticulture Australia's scheme to encourage voluntary contributions for R&D from downstream industry partners.

Some RDCs have also established Research advisory bodies to help refine the scope of research being undertaken to ensure that they meet stakeholder needs. The FRDC has established such mechanisms in each State and all research gets assessed and prioritised by these groups.

Factors determining success

The outstanding features of the RDC model that have led to its successful implementation include:

- The underlying industry driven and market responsive premises;
- The framework arrangements provided by Government policy support, including the legislation governing RDC operations and the system for compulsory levies on producers and their collection and disbursement;
- The co-investment philosophy provided through the partnership with government centred on the matching of industry levies, and the creative contribution and leverage provided by research partners;
- The strategic management framework which underlies RDC operations and ensure that they maintain corporate commercial standards of planning, program management, accountability and reporting ; and
- The scope and flexibility provided by the corporation status and operating arrangements for RDCs.

RDCs are in effect custodians of the technological future of their industries and within the limitations set by their legislation and the application of government policies they have considerable flexibility in how to pursue this in conjunction with their industry and research partners.

Strategies in other countries that may be of instruction to Australia

RDCs are actively involved in international forums and commonly seek overseas expertise in reviewing R&D programs and projects. This interaction also facilitates the understanding and consideration of alternative strategies. There are also many other examples of commercial marketing and promotion strategies that rural industries as a whole can learn from. RDCs are also active participants in the Forum for European and Australian Collaboration on Science and Technology (FEAST).

There are, however, natural and obvious limitations to the applicability of overseas models and systems for innovation to the Australian situation. This is in view of the need for these to be relevant, given the size and nature of the Australian economy and the circumstances prevailing over the nation's innovation system. In this context it is important to note that the RDC framework arrangements, which have been developed to meet particular Australian requirements, are considered to be a world's best practice model for industry innovation. There have been numerous enquiries over many years for information on it and the steps and processes involved in its implementation. Many overseas competitors to Australian producers (for example in the grains and cotton industries), in fact comment favourably on the RDC model and cite it as a source of competitive advantage for their Australian counterparts.

Certain features of the RDC model, including the industry driven and market responsive approach and the underlying co-investment and strategic management principles, may well have applicability to other Australian industry sectors. Such application could assist in building a strong innovation culture and in promoting development of industry clusters to underpin successful penetration of global markets. Harvard Professor Michael Porter, the leading international economic strategist and advocate of cluster development as a basis for

building competitive advantage, describes the Australian Wine Industry as the best example of a successful industry clusters. This arises from the successful integration, with encouragement from the Grape and Wine RDC, of wine industry activities and those of associated industries, with inputs from education institutions, functional structures for development of innovative technologies, and regional communities.

Section 3: SUCCESSFUL AUSTRALIAN TECHNOLOGICAL INNOVATIONS

The following case studies and examples from a sample of RDCs are provided to illustrate the way in which RDCs progress the development, take-up and commercialisation of innovative technologies.

Cotton Research and Development Corporation (CRDC)

The CSIRO/CRDC cotton breeding program is one of the most successful of its type in the world. World leading cotton varieties are being developed with continuous improvement in yield, quality and agronomic performance through plant breeding and biotechnology innovations. These varieties are commercialised in Australia and overseas through an industry partner Cotton Seed Distributors. By several measures it is an exceptional case study in commercialisation of R&D:

- Australian cotton is consistently one of the top two prices listed on international markets due to its high quality.
- Australia has the world highest yields for a major producer - with a 21.6% increase over the past five years.
- New CSIRO varieties have delivered a 11% water use efficiency improvement
- A return of over $5 billion to the Australian cotton industry since 1973, with a benefit to cost ratio of 86 (Centre for International Economics)
- CSIRO varieties comprised 80% of the Australian crop planting in 2004/05. This included 14 new varieties released in 2004 with improved features such as yield, fibre quality, disease resistance, maturity, regional adaptability, genetically engineered insect and herbicide tolerance.
- Bollgard II varieties have been genetically engineered to contain a naturally occurring soil bacterium, Bt, which controls the major insect pests of cotton. This innovation has led to significant reduction in pesticide use, up to 85%, and improvement in the environmental performance of the industry.
- CSIRO varieties now hold a 15% share of the US cotton seed market.
- The Cotton RDC share of royalties in 2004/05 is estimated at $1.5 million and represents over 10% of its annual income.

DAIRY AUSTRALIA LIMITED (DAL)

The Dairy Industry today

Australia's dairy industry is the country's largest processed food industry. It is worth more than $7 billion a year and contributes $2 billion to Australia's balance of trade. Australia is now the world's third largest exporter of dairy products - behind New Zealand and Europe. Australia has more than 2 million dairy cows producing around 10 billion litres of milk each year. The Australian climate and natural resources support production based on year-round pasture grazing.

Most farms are family owned and operated and have become larger and more efficient. Although the number of dairy farms has decreased (from 22,000 in 1979/80 to below 10,000 in 2003/4), production has increased. This is largely due to farmers continued adoption of latest technologies and the search for ways of increasing productivity through such things as improved pasture, feed and herd management.
Sustainable growth in the supply-side of Australian dairying is a vital aspect of industry R&D. Long-term commodity returns are in decline at the rate of 1-2% a year. Consequently, Australian dairying has to stay competitive through economies of scale and productivity — and through innovation and commercialisation.
Dairy Australia contributes to the industry's competitiveness by overseeing industry-good R&D within the Australian dairy industry. A production-based farmer levy is matched by Federal Government funding and augmented by royalty and IP payments.
In 2003/4 Dairy Australia spent $29.9 million on R&D to benefit the Australian dairy industry and the community.
Australian dairy R&D continues to tackle ongoing challenges to commercial linkages.
Two case studies handling commercialisation follow.

DAL Case Study 1: INCALF: A fertility friend

CHALLENGE: Changing industry conditions
SOLUTION: Covering all bases

InCalf is now a national learning program funded by dairy farmers for dairy farmers through Dairy Australia. It started as research to answer a basic question: Why were fertility levels falling in dairy herds?
Since its inception in 1996, InCalf has been working with dairy farmers and advisers to achieve measured improvement in herd reproductive performance.
Concurrently, however, the industry has seen major shifts in calving systems and successes in response to severe drought and shifts in farm gate payments. Changes require a learning package relevant to all systems.

What is Incalf?

The first phase of InCalf involved a ground-breaking on-farm research study on a massive scale. It involved nearly 40,000 cows from more than 200 commercial herds around Australia and is believed to be the largest project of its kind undertaken anywhere in the world. The study produced a superb database that provided detailed information on the management practices that drive and yield good fertility in Australian dairy herds.
The second phase, in 2000-2001, saw the key findings communicated to 2000 farmers and more than 400 advisers through a series of seminars and publications.

Through this information awareness phase, farmers indicated that knowing the information was one thing, building it into their managements systems was another - they needed support to bring about real improvement in their herds – an extension package was required.
In 2002, InCalf Phase 3 commenced with further funding through Dairy Australia. Intensive development produced an innovative package of resources and tools, and training programs – the new InCalf learning package.

What has changed?

A random sample of 1200 national dairy farms in 2004 asked farmers about their calving systems. A total 11 percent of respondents indicated they had altered their calving system over the past year. A further 6 percent indicated they planned to change in the coming year. Reasons driving change included better milk prices/incentives, improved cash flow; herd fertility issues; easier workload and seasonal conditions.
Additionally, dairy farmers are seeking best-practice advice from advisers such as veterinarians to push productivity. For example, Mundijong dairy farmer, Lisa Brazier, has challenged vets and other advisers to train-up on InCalf's new resources and tools. "There's only about 300 dairy farmers left in WA now and if we lose any more, we'll soon find our industry has vanished," she said. "Advisers including vets and nutritionists have an important role to play in ensuring our industry survives."

What has happened?

InCalf has determined realistic targets for reproductive performance in seasonal, split and year-round calving herds and the typical financial benefits of improvement.
It is recognised that every farm is different, subject to many variables both within and outside the farmer's control year to year. Even on the same farm the 'best' calving system is not fixed and may change under different circumstances.
InCalf is introducing a new process to evaluate whether or not it would be profitable to change calving systems.
Armed with InCalf data, farmers are being advised to seek professional advice and then make sound decisions on whether to change from their current calving system to an alternative.
Project leader Dr Steve Little said "InCalf now offered farmers a detailed analysis of reward and risk considerations. It has taken us where few have gone before and provided some very important insights into the profitability of calving systems, as well as the process of assessing profit for decision making."

DAL Case Study 2: RecaldentTM: A question of scale

CHALLENGE: Commercialising R&D on a global scale
SOLUTION: A network of partnerships and alliances to handle development and marketing

A major dentistry discovery brought smiles to the faces of Professor Eric Reynolds and his team at the University of Melbourne.
For nearly a century, dentists have aimed to prevent or reverse tooth decay. And the Melbourne team had done it.
A discovery likely to be worth multi-billions; how do you handle something that big?

What is Recaldent?

The ingredient known as Recaldent™ is derived from casein, part of the protein found in cow's milk. Its technical name is casein phosphopeptides-amorphous calcium phosphate, or CPP-ACP.
Professor Eric Reynolds and his colleagues at Melbourne University's Dental School found a peptide in milk that when added to chewing gum binds to tooth enamel and slowly releases calcium phosphate into the tooth, repairing damaged tooth enamel.
Recaldent™ works to safely strengthen teeth by delivering calcium and phosphate (the building blocks of tooth enamel) in a unique soluble form to help remineralise tooth enamel.
Halting and reversing the process of tooth decay is such an important advance that Recaldent™ is being accepted around the world and it is a multi-billion dollar market.
But the discovery was only the first step. Taking it from the lab to the world involved an extensive dairy team.

The global challenge starts

Dairy Australia provided linkages to bring the discovery to commercial success.
The University of Melbourne and the Victorian Dairy Industry Authority patented the CPP-ACP complex.
Bonlac Foods acquired exclusive manufacturing and marketing rights and owned the Recaldent™ trademark.
Recaldent™ was launched as the result of close co-operation between the University of Melbourne, Bonlac Foods and the Victorian Dairy Industry Authority (VDIA).

The VDIA supported the university researchers. Bonlac Foods constructed the commercial manufacturing facility and provided the technology to market Recaldent™. CSIRO's Food Science Australia assisted in the scale up of the manufacturing process.

Bonlac Foods received an R&D Start Grant from the Commonwealth Government and also took advantage of matching funds from the Dairy Research & Development Corporation (a forerunner of Dairy Australia).

The intellectual property in the CPP-ACP rests in three areas — the technology itself, the manufacturing process and the Recaldent™ brand.

The involvement by Bonlac was a critical success factor. The milk processor maintained close alliances with independent research organisations, such as Dairy Australia, and recognized the potential value of considering independent research outside of its traditional bounds, for example dental care. This wider scanning of the research environment ultimately led Bonlac to undertake the innovative development of the product.

The results

In early 1999, the US Food and Drug Administration accepted the status of Recaldent™ as GRAS (Generally Recognised as Safe).

Recaldent™ was introduced as an ingredient in Warner-Lambert's Trident Advantage™ and Trident for Kids™ sugar-free chewing gums in the USA and Europe in late 1999 and in Japan in early 2000. A sugar-free mint containing Recaldent™ (Trident Advantage™ Mints) was launched in the USA in late 2000.

The Recaldent logo is carried on the front of all packaging and the dental care benefits of Recaldent™ are the primary feature of advertisements for the product.

The addition of Recaldent™ to other oral care products and the use of the CPP technology in other applications are expected to follow in the coming years and potential customers are already evaluating the product.

Recaldent™ is also the main ingredient in GC Tooth Mousse, launched by the Asian division of the Japanese Dental Company GC Corporation.

FISHERIES RDC (FRDC)

FRDC Example 1: Australian Livestock Feed Ingredient (ALFI) Database.

The Australian Livestock Feed Ingredient (ALFI) database is an interactive database for Access program software on nutritional quality of locally-grown grains for pigs, poultry and aquaculture species. It provides detailed information on feed ingredients including nutritive value (nutrient digestibility and availability) and chemical composition (proximate, amino acid profile, starch, non-starch polysaccharides, fatty acids, soluble and insoluble sugars, vitamins, minerals, anti-nutritional factors and toxins) along with growing environment of the ingredients, how the ingredients are stores and processed, physical features and the methodology employed for chemical analysis and nutritional evaluation.

ALFI allows users to compare species or varieties within a location or between locations, search for a particular region, retrieve data collected from a laboratory or contributed by a particular researcher, and to communicate with researchers. It will ensure that users get information relevant to their livestock feeding situation, which will result in improved feeding efficiency and reduced livestock feed costs.

Potential users of ALFI are researchers, members of the grains industries, feed manufacturers and users, nutritionists and plant breeding as a diet formulation reference, variety comparison and quality control in trading.

This system have been commercialised through agreements with the feed manufacturers who now update it with the latest information and on-sell. The product is available from the GRDC website http://www.grdc.com.au/bookshop/sale.htm.

FRDC Example 2: Australian Seafood Co-products (ASCo)

An FRDC funded subprogram has set up the Australian Seafood Co-products (ASCo), a company whose goal is to sustainably use fish and fish co-products that are not traditionally utilised or marketed.

ASCo shareholders include FRDC and seafood companies from Queensland, New South Wales, Victoria, Tasmania and South Australia, Their initial shareholder contributions are being used alongside government funding to run R&D projects to help get ASCo off the ground. Projects completed include:

- Feasibility of installing fish silage plants at central processing sites;
- Development of an ASCo business network plan;
- Development of an ASCo operating structure.

Pilot plants have been set up and commercial production and sales are planned to begin in December. FRDC and the Department of Primary Industries (Victoria) are funding scientific trials of *Biophos* on crops including tomatoes and dry and irrigated pasture.

FRDC Example 3: Lobster breakthrough a world first

"This breakthrough science is of major international significance for lobster aquaculture," says Professor Buxton. "We're finally producing consistently high numbers of larval lobsters in captivity and we expect many of them to go on to the juvenile stage."

Colin Buxton says the research breakthrough is expected to lead to commercial production of hatchery lobsters and it has attracted much interest from investors and industry groups in other countries.

"This breakthrough was the result of good husbandry, good health management and a great science team," says Professor Buxton.

He says the wild lobster fishery has nothing to fear from this discovery because lobsters produced by aquaculture would be marketed at a smaller size and would therefore require a different marketing strategy.

Commercialisation of the discovery will take between 10 and 15 years, by which time international demand for seafood Commercialisation of the discovery will take between 10 and 15 years, by which time international demand for seafood is expected to significantly outstrip supply.

GRAINS RESEARCH AND DEVELOPMENT CORPORATION (GRDC)

Over the last 20 years Australian crop producers have achieved average annual productivity growth rates of around 3%, which keeps them ahead of the average annual 2% decline they face in their terms of trade. The contribution of grains R&D to that increase is attributed at 1.7 %. As a prime example of success, application of advanced farming systems in Western Australia focussed on early sowing on opening of rains for the season have increased in recent years by a huge 50%. Using wheat as an example the average yield from Australian wheat production over the last 20 years has increased by 2.5% per annum. In comparison, annual gains over the same period by the major international competitors to Australian grain producers are 0.6% for the USA, and 2.3% for Canada.

Grower surveys report that 67% of growers claim to have benefited directly from GRDC related activities in the last five years and 76% believe that GRDC is addressing long-term sustainability threats.

GRDC Example 1: Molecular markers—speeding the breeding

The Australian Winter Cereals Molecular Marker Program began in July 2002, bringing together 33 projects. It followed the GRDC's initial investment in research into molecular markers for wheat and barley breeding, conducted from 1997 to 2002. The program's overall objective is to use 'marker-assisted selection' techniques to accelerate the breeding of improved wheat and barley varieties. It includes the discovery and application of molecular markers for a range of key traits, including wheat and barley quality attributes, resistance to major diseases, and tolerance to abiotic stresses.
The program comprises three working groups of projects: Enabling Technologies (7 projects), Genetic Analysis (14 projects), and Validation and Implementation (12 projects). A consolidated molecular marker program supports information flow and cooperation between the working groups.

The program is having a valuable impact. For example, marker-assisted selection is being used to speed up the development of new Australian wheat varieties. Use of markers is reducing the assay time for specific traits, as well as allowing simultaneous screening for many traits, including nematode resistances, rust resistances, plant height, and boron tolerance. Using markers in early generations enables wheat breeders to increase the selection pressure for other more complex quantitative traits in later generations. The result is an increased rate of genetic gain.

In barley, marker-assisted selection is being used by GRDC-supported breeding programs to enhance the frequency of genes that condition desirable traits, such as malting quality and disease resistance. Using marker-assisted selection in conjunction with other fast-track approaches (e.g. use of doubled haploids) is reducing time from the first cross of parent plants at the start of the breeding process to final variety release from 12 years to 8 years.

It is expected that in future:

- Implementation will be further accelerated by the advent of new technologies such as Diversity Arrays Technology (DArT);
- DArT in particular will become financially self-sustaining as demand for molecular marker technology from breeding entities increases. This will help to offset some of the costs of running the program.

GRDC Example 2: Using DNA 'spies' to track insect movements

The voracious caterpillar *Helicoverpa armigera* is a major crop pest, but understanding the migration patterns of the adult moths has been difficult. In world-leading research conducted at the University of Queensland, with a network of collaborators across Australia, researchers are using 'microsatellites' to provide fundamental information on the insect's movements.

Microsatellites are small pieces of DNA which change structure rapidly and dramatically between generations. The portion of DNA being used varies in length between different *H. armigera* populations. This means that as populations migrate and interbreed new lengths of DNA emerge. By monitoring these changes, *H. armigera* migration patterns can be shown to vary between years. During the 2002–03 drought, the pests stayed in the region from which they emerged. In better years, such as 2001–02, they were seen to move in small steps in many parts of eastern Australia.

The data suggest that *H. armigera* populations generally originate from cropping areas rather than migrate in single large events from central Australia, as was previously thought. Since the distance migrated depends on the season, it is now clear that control at a farm level is the key to minimising population growth. This work is considered to be the world's most intensive pest research project using genetic monitoring tools.

GRDC Example 3: Root threats: mapped from space

The marriage of satellite yield-mapping technologies and soil tests uses frontier technology to study the causes of yield variations in paddocks, in research supported by the GRDC through the South Australian Research and Development Institute (SARDI).

Root diseases and pests substantially reduce crop yields, costing Australian grain growers millions of dollars each year. Major problems include diseases like take-all, cereal cyst nematodes and root lesion nematodes.

In 2002-03, SARDI scientists used the combined technologies to show that each paddock has zones of root diseases and pests, in the same way that there are variations in nutrient levels, or different soil types. Each factor limits yields.

Furthermore, they found at least one disease or soil pest active in every paddock, that disease pressures could be mapped into zones within paddocks, and that diseases were not evenly distributed.

The on-going research will establish the best approaches for disease mapping. It will also find ways to benefit the industry through reducing the risk of disease losses in precision agriculture farming systems and lay the groundwork for new technologies in site-specific disease management.

GRDC Example 4: Biotransformation - the dawn of a new Australian industry

Worldwide, the chemical industry is on the threshold of a revolution. It is shifting from petrochemical to biological feedstocks and chemical catalysts. Many will be sourced from crops.

This is the shift to biotransformation. It is being driven by diminishing petrochemical resources, concerns about high energy and high waste chemical manufacturing processes, and an increasing demand for complex chemical products, that can be made only from biological catalysts.

Major multinationals, such as DuPont and Dow, have committed to targets of around 20% biotransformation for their raw materials by 2020 and have already begun to commercialise plastics and other biopolymers made from corn.

Biotransformation can be done either in plants (crops as biofactories) or by fermentation (in bacterial biofactories). Crop biofactories have the advantages of versatility (able to produce a wide range of protein, carbohydrate and oil chemistries), low infrastructure demands and ready scalability.

With an efficient agricultural base, excellent R&D capability and a growing market, Australia has the potential to be a world leader in biotransformation.

In 2002-03, the GRDC's Value Chain Program set out to gather market information and analysed world trends in biotransformation – to help improve the market orientation of GRDC's research investments and to underpin Australia's competitive performance.

For the GRDC, the question is: 'with so many opportunities, which ones should the Australian grain industry exploit?'

To help answer this question, in partnership with the CSIRO and the Rural Industries R&D Corporation, the GRDC supported an international workshop on biotransformation. Topics ranged from industrial oils and enzymes to plastics and polymers from crops.

The workshop identified several potential investment opportunities and developed the broad parameters of a business case for each. Critical to the success of the workshop was the participation of an international panel of scientists. They contributed extensive experience and ensured that the focus of discussions remained on the commercial potential of the opportunities identified, while not forgetting the science involved.

Due to the complexity of the research, intellectual property and commercial issues involved, the CSIRO and GRDC have agreed to undertake further analysis of the investment opportunities identified at the workshop, including the identification of potential commercial partners.

GRDC Example 5: Zero-till has the edge in machinery costs

Reduced till and zero till farming systems have the lowest machinery costs in the southern Mallee of Victoria. This was shown in economic evaluations of the machinery used in four different farming systems by the Birchip Cropping Group in Victoria, at its farming systems trial site in 2002.

The Group compared a hypothetical farming model with contract rates for all major farming operations carried out within the trial. A key assumption made in the analysis was that the hypothetical 1,500-hectare farm was situated in the southern Mallee of Victoria, on a soil type similar to that of the farming systems trial site. Fixed and variable machinery costs were analysed on a whole-farm and per-cropped-hectare basis.

The methodology allowed the economic work to be presented to growers from a whole-farm perspective. As a result, farmers in the district related easily to the whole-farm figures, creating a large amount of debate at a number of Birchip events.

GRDC Example 6: Aquafeed—high hopes for higher returns from Lupins

The aquafeed market as an important, potential new growth opportunity for the Australian grains industry. One project, led by the Centre for Legumes in Mediterranean Agriculture and strongly involving the Western Australian Department of Fisheries, has been examining the potential to develop value-added plant protein products derived from lupins for the aquaculture feeds sector. This project aims to identify lupin protein products that are nutritionally and commercially viable for use as aquaculture feed, and then transfer the technology and know-how to the private sector for commercial development.

Four lupin protein concentrates have been developed, and initial feeding trials using rainbow trout indicate that these products have excellent nutritional value. Generally, the lupin products were equal or superior to soybean products, which will be the major plant protein competitor in aquafeed markets. Further feeding trials with rainbow trout and Atlantic salmon will begin shortly in both Australia and Norway.

The prospect of targeting the aquafeed market with lupin concentrates has prompted GRDC-supported lupin-breeding programs to branch out into this area and commence new work alongside the longstanding breeding programs. The new work aims to identify *Lupinus luteus* varieties with high protein levels and develop them further as a source of aquafeed with superior nutritional value.

Such is the potential of this project that it has attracted new research and investment partners, including the Fisheries Research and Development Corporation, as well as significant private sector interest. The participation of private sector partners will greatly assist in the commercial adoption and 'up-scaling' of project outputs, which will be essential for the development of a new lupin-based aquafeed industry centred in Western Australia.

GRDC Example 7: Tramline farming gains momentum in Western Australia

A series of studies carried out through the Western Australian Department of Agriculture to quantify the costs and benefits of tramline farming (TLF)—a form of controlled traffic cropping—were completed, with results summarised into the very popular *Tramline Farming Systems Technical Manual*.

In many soil types, ranging from deep sands to clay loams, TLF greatly reduces soil compaction in the cropped areas between the wheel tracks, with increased yields of 5 percent to 15 percent recorded. There are also significant savings in fuel use and spraying overlaps, and benefits in getting onto the paddock earlier after rain. Field trials have shown a potential reduction in inputs of 3 percent to10 percent, and overall benefits of $40 per hectare or more.

TLF is beginning to gain popularity in Western Australia, with more grain growers each year adopting a full or partial controlled traffic system. The GRDC has also invested in work to identify the continuing difficulties faced by grain growers in selecting machinery with matching wheel spacing, a key requirement for TLF.

GRDC Example 8: Reducing pesticide residues in food

Proper grain storage and handling methods, including control of insect pests that feed on stored grain, are essential to maintain grain quality and value. However, issues such as increasing levels of resistance to the grain fumigant phosphine in stored grain pests, occupational health and safety, and phosphine residues in grain have made improving phosphine application practices an industry priority. It is estimated that losing phosphine to pest resistance could cost the industry $40 million per annum. As a result, the GRDC supports research into alternative chemical and non-chemical (e.g. heat) methods to control stored grain pests. One project is exploring safer and more sustainable ways to use phosphine, while another is supporting the commercialisation of carbonyl sulphide as a replacement fumigant for the ozone-depleting methyl bromide.

Survey data gathered by the GRDC in recent years indicate steady progress in transforming the industry, with 23% of growers surveyed indicating that they had changed insect management treatments for on-farm storage for the better in the 12 months preceding the survey. Key changes made included: increased use of sealed silos, applying phosphine in a manner that reduces the risk of residues in grain, and increased awareness of the occupational health and safety risks of misusing phosphine.

GRAPE AND WINE RDC

Transformation of the Australian Wine industry is well documented, including through a paper produced for the Prime Minister's Science, Engineering and Innovation Council (PMSEIC), 'The Australian Wine Industry – success through innovation' (Occasional Paper No 3, PMSEIC Fourth Meeting, 26 November 1999).

Brief details are provided below on the industry's exceptional development.

Industry development

In less than a decade Australian wine has gone from a largely domestic product to the current position of about 60% of its value (more than $2.5 billion) being derived from export success. Over the 20 years the RDC model type arrangements have been in place total industry exports have experienced a staggering increase from less than $10 pa to the current figure of more than $2.5 billion pa.

This success has been driven by investment that has built from the confidence of grape growers and winemakers in having access to innovation that will improve their business outcomes meet demands for sustainable systems. They have used and continue to demand technological options that will enable them to address production costs, but more importantly the demands of a range of global consumers. Not only has the innovative culture changed practices, but importantly for ongoing trade, it has introduced large new markets sectors to the enjoyment of wine. The strength of partnerships between the Grape and Wine Research and Development Corporation and those involved in the wine business is based on the recognition of the absolute need to rapidly share information along the value chain from the consumer to the grape grower if Australia is to continue as "the world's most influential and profitable supplier of branded wines".

Closures

In addition to this general position, specific research on wine closures (corks, synthetics, screw caps) has seen very rapid adoption and change within the industry. This is one research investment where the global industry change can be very closely linked to the publication of research from the Australian Wine Research Institute that was an RDC investment. The speed of change was driven by two factors both of which were clarified at about this time. The first was that new analyses of the traditional closures, cork, were showing an unacceptable issue with quality control. The second was the clear demonstration the flavour profiles of fine white wines could be more predictably retained under alternative closures such as screw-caps.

Adoption of new closure technology has been rapid and has developed high rates of commercial returns for the industry including benefit to cost ratios of 186:1. This example has also demonstrated the benefits which flow from access to new industry technologies. A number of wine companies invested considerable time and effort of their own in working through the practical aspects involved in innovation of the closure technology. One large company in particular employed a full time operative to work in tandem with researcher on the implementation processes attendant to the innovation. This information was made freely available within the industry so that the smallest and most remote wine makers could draw on the findings of these processes on equal terms to other producers.

MEAT AND LIVESTOCK AUSTRALIA (MLA)

MLA Case study 1: Beef quality gene markers

Context

Beef gene markers are a technology that can assist in identifying, selecting and breeding from beef cattle with meat quality traits that suit specific market needs. This allows the industry to more efficiently produce quality meat through selection at an early stage of feeding, thereby reducing costs, or by selective breeding. Gene markers enhance existing genetic evaluation programs by providing methods to identify discrete elements of genetic variation, in some cases, for characteristics that are not easily measured in living animals. The combination of gene markers and genetic evaluation provide tools to increase the rate of genetic improvement in industry herds and flocks. Gene markers may also be used to select which animals go into specialised production systems.

Technology summary

The characteristics of red meat that give rise to variations in eating quality are partly determined during the growth of the animal by the complement of genes. Variation in gene sequence and corresponding function are responsible for some of the variability in eating quality. Gene markers are indicators of gene differences between animals. Typically they are a single base variation which is, or is near to, the gene affecting the trait. The tests are conducted on DNA extracted from a sample taken from the animal of interest (in the case of beef cattle, usually hair, but it can also be blood, semen or tissue). Currently Meat & Livestock Australia (MLA) and their partners have licensed gene markers made available to the cattle industry for two important traits – marbling (fat content and distribution in meat) and tenderness. Both of these traits are important eating quality attributes. At present one commercial partner is offering three gene markers each for marbling and tenderness. Because a gene marker is an indicator of only part of the genetic variation affecting a trait, multiple markers are possible and required to continuously improve the target trait.
MLA partnered with the CSIRO to discover the first gene marker for marbling, and also with the Beef CRC and CSIRO to discover the first gene marker for tenderness. The research program commenced in 1989, with initial investment by the Meat Research Corporation, and was accelerated in 1993 with the advent of the Beef CRC.

The products (tests) are marketed under the GeneStar brand by a technology start up company, Genetic Solutions.
The marbling marker technology provides the user with the capacity to test cattle before entry into a feedlot. The information in the gene marker profile is used to determine which animals to continue on feed for demanding markets. This reduces the cost of feeding by culling animals that would otherwise have a low chance of achieving specifications. Apart from reducing feeding costs, it increases the ability to forward sell into demanding export markets.
The use of tenderness markers increases the chances of breeders selecting tropically adapted animals with more tender meat. This flows on to improved customer satisfaction with the product and ultimately increased sales.

In each case, gene markers are used by breeders to determine which cattle to join to increase the chance of their calves better meeting future specifications.

Commercialisation and adoption: Outcomes and current status

Australian and international (predominantly North American) sales of gene marker tests to date are in excess of 15,000 tests for GeneStar marbling and 20,000 tests for GeneStar tenderness. The information for tests conducted in Australia is made available to the national beef cattle genetic evaluation scheme (BREEDPLAN).
Further investment in the development of beef gene markers is through:
a) MLA funded research and development (R&D), predominantly through the Beef CRC;
b) Independent investment by the Beef CRC;
c) Collaborative research and commercialisation agreement with the Beef CRC, CSIRO and the commercial partner Genetic Solutions; and
d) MLA Donor Company when near to market evaluation is required.
This pipeline of R&D and commercial arrangements is generating from 2–3 new gene markers each year. Our approach is to protect each gene marker by appropriate patents and to license rights to commercialise to a commercial partner.

Commercialisation and adoption strategy

The adoption of gene markers by industry is facilitated by ready access to a commercial partner who provides all the sampling and testing services. The results of the tests, in Australia, are made available to BREEDPLAN (the national genetic evaluation program). Over the three years since the first GeneStar marbling marker was launched, prices have fallen by over a third, in line with savings through increased throughput and improvements in technology. This trend is expected to significantly outstrip supplycontinue.
The package of gene marker technologies is licensed to Genetic Solutions by MLA, Beef CRC and CSIRO under a collaborative research and commercialisation agreement (CRCA). Under the terms of the CRCA, each new marker (covered under the license) is available to be licensed if it meets strict technical and industry value criteria.
Licenses are offered exclusively, but constrained by field of application, jurisdiction and by specific marketing plans with set sales targets in each jurisdiction. Failure to achieve targets set in the marketing plan may place the license in jeopardy. It is the responsibility of the commercial partner to conduct marketing activities, for each test, with the object of maximising sales.

The industry strategy and commercialisation strategy relationship is summarised below.

Industry objective

- Increased beef eating quality and capacity to achieve marbling specifications

Research strategy

- Establish a functional connection between investment in improved genetic evaluation systems and development of new technologies arising from molecular biology.
- Build large scale databases from measured industry animals and DNA for use in molecular genetics R&D.
- Conduct "fundamental" R&D to discover gene markers that can be used to select more tender animals and identify those with higher propensity to marble.

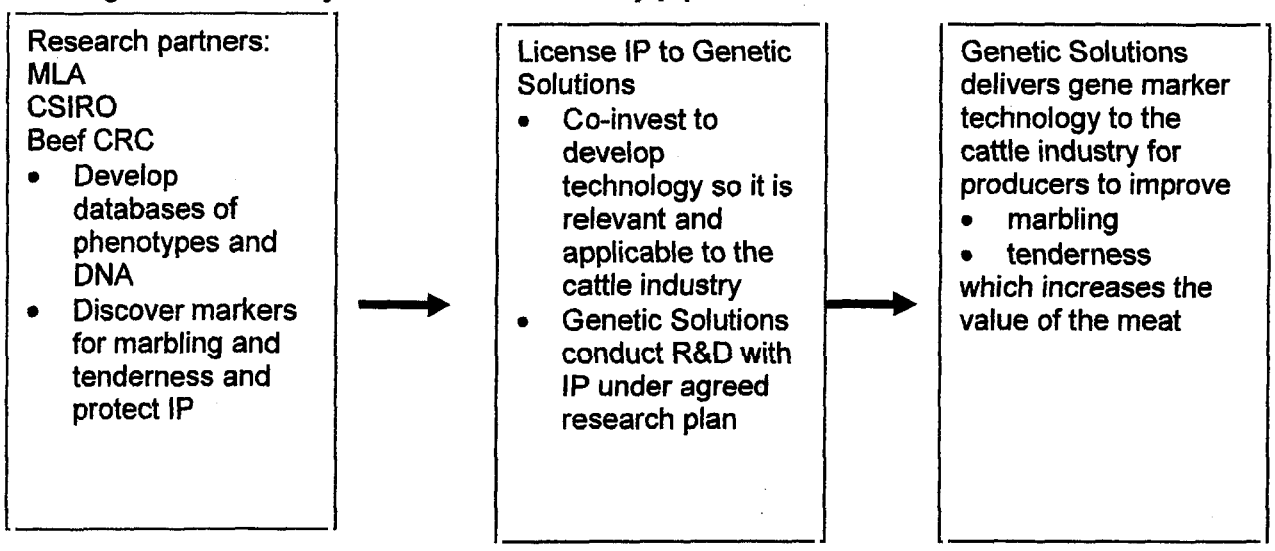
Development strategy

- Patent gene marker discoveries.
- License a package of underpinning data and know how to Commercial Partner.
- Conduct "near to market" R&D with the commercial partner to evaluate tests in industry herds.
- Provide technology licenses to the commercial partner on a case by case basis for each gene marker.

Commercialisation arrangements

- Exclusive license for commercialisation of technology (each gene marker, constrained by field, jurisdiction and by marketing plan)
- Rights to sub-license (overall, but explicitly in jurisdictions where local presence is important)
- Terms to deliver more favourable to Australian users than to overseas users.

Figure 1: Summary of research to delivery pipeline



Summary of the commercialisation plan:

- Intellectual property – confidential information (umbrella agreement that leads to a collaborative research and commercialisation agreement) and patents to protect specific information
- Commercialiser – selected from expression of interest based on assessment of capacity to build the technology/user interface. MLA provides no explicit support, although we will partner donor company arrangements for near to market evaluation.
- Agreements – licences, specific requirements (such as market focus), royalties, exclusivity, performance requirements etc.
- Value proposition for commercialiser – based on exclusivity of license and their ability to extract value from the technology.
- Off shore commercialisation – encouraged through marketing plan, but sub-license arrangements offered when it is obvious that the most effective arrangements are to use local knowledge.
- Capital requirements (financing plan) – none done completely at commercialisers risk.
- MLA exit strategy – we are locked into the commercial arrangements for the life of the patents, except where performance against marketing plans triggers change in terms of license (non-exclusive at first, followed by loss of license). We want the commercialiser to succeed, and if they don't succeed, we reissue the license. However, it is at no cost (other than transactions in issuing new licenses) to MLA for the commercial partner to continue (indeed, as time goes, on our royalty stream increases).

Industry benefit

There is as yet no direct economic data on effect of the gene markers in industry herds.

However, uptake by industry is increasing. The tenderness gene markers are outselling the marbling markers. This is due to the perceived benefit on increased tenderness through MSA. It is anticipated that future benefits will arise as the users of the tenderness tests in Northern Australia see a return in *Bos indicus* cattle.

With respect to marbling, the use of animals with the positive alleles for the 1st of the gene markers results in a 0.2 increase in Ausmeat marble score overall and a 10% decrease in animals within the lower marbling grades. This translates into real economic benefit for the feedlot who purchase cattle with the positive marbling alleles. There is an expectation that this will flow through to calf producers over time.

MLA Case study 2: Predictive microbiology

Context

Australia has exported red meat for over two centuries and currently services more than 150 markets around the world. Globally, the regulatory climate under which we trade meat has changed radically in the past decade following serious public health concerns such as BSE. Domestic regulation also changed radically following meat-associated illness in the mid-1990s. Worldwide, meat safety has become a non-negotiable basis for market access.

MLA's food safety program has maintained a lead position for the Australian industry, both for enterprises and regulators, by providing strong scientific underpinning for new, risk-based regulation acceptable to over 100 trading partners. As a result Australian companies have traded unimpaired, avoiding the major disruptions suffered by many competitors as a result of meat safety concerns.

Pivotal to enhancing the industry's trading position is MLA's investment in predictive microbiology, a tool now used routinely by every sector of the meat processing industry.

Technology summary

Predictive microbiology brings together information on how microorganisms grow or are inactivated, particularly those that affect the shelf-life and safety of foods. This information is transformed into a mathematical model that informs on how meat safety is affected by industrial processes. Such models are then used by industry to improve process control and by regulators to draft modern, outcomes-based regulations. A full validation of predictive microbiology applications in meat processing has been completed to provide AQIS with the scientific underpinning, should this be required by an importing country.

The identified benefit derived by industry from predictive microbiology is the culmination of nearly 8 years of research with a value of approximately $400,000.

In the Australian meat industry predictive microbiology is now used routinely in:

Export Control Orders

In the Export Control (Meat and Meat Products) Orders 2005, predictive microbiology forms the underpinning of regulations for chilling and cold storage via the refrigeration index. Each exporter will use the refrigeration index to satisfy its customers that it is using validated processes for controlling temperature of its products.

Hot boning

The refrigeration index replaces the hot boning index, which was developed to secure sound, scientifically-validated regulation for this sector, replacing the former approved arrangement.

Weekend chilling of beef

Predictive microbiology is used to validate weekend chilling regimes by providing a sound scientific basis for their use.

Rewarming of carcases

In a significant proportion of the industry, boning of carcases has occupational health and safety issues due to the difficulty of incising hardened fat. The process of rewarming carcase surfaces to prevent injury to operators without impairing meat safety is validated using predictive microbiology.

Refrigeration breakdowns on-plant

When refrigeration systems malfunction, plants are required to prove that any product affected by impaired chilling regimes is still fit for human consumption. The predictive microbiology tool is now used to assess fitness of these products.

Cooling of cooked meats

Meats that are cooked (eg hams, comminuted and roasted products) are subject to a three-stage process for cooling. This regulatory standard is unattainable for products of large dimensions even using the most efficient chilling systems. Predictive microbiology is used on-plant to validate chilling regimes and was instrumental in providing the scientific underpinning for amendment to the Australian Standard.

Uncooked comminuted fermented meats (UCFM)

Following the mettwurst-associated disease outbreak of 1995, interim regulations were introduced to improve the safety of UCFM. Recently, MLA was instrumental in having the regulations revised to produce a sound, scientifically-based regulation for the sector by providing a predictive microbiology tool for use by operators and regulators that would predict the safety of the production process.

Commercialisation and adoption strategy

Commercialisation and adoption of predictive microbiology by the Australian abattoir and processing sectors has been completed. Strategies used for dissemination and uptake of predictive microbiology by the industry have followed a pathway of:

- international scientific validation of the concept;
- industry/regulator acceptance;
- development of predictive microbiology tools;
- market testing; and
- dissemination to industry.

Pivotal to acceptance of predictive microbiology is the scientific rigour of the research and development undertaken by university and government scientists under contract to MLA. Because much of the science of predictive microbiology is both novel and fundamental, it must be tested in a global, peer-reviewed context. This has been done via MLA publications and in the international literature.

Industry and regulatory acceptance was secured via expert panels in which MLA facilitated scientific and technological interplay between industry and regulators.

A series of tools developed for specific sectors and products across the industry were market tested and evaluated in a single jurisdiction or through test marketing, prior to refinement for dissemination across the industry as a whole.

Uptake of predictive microbiology was facilitated by: a series of workshops run by MLA for operators and regulators in each state; engagement of regulatory committees and standards writing groups; publications disseminated to industry; and provision of industry consultants and help lines.

The twin objectives of MLA's food safety program – meat safety and market access – have clear 'public good' bases both for the public health and wellbeing of consumers and for the economy of the agri–meat–retail continuum. Any loss of market access, such as those suffered by the Canadian and US meat industries, would have ramifications across Australian society.

For these reasons the MLA food safety program operates in a 'free-to-air' manner where every meat establishment and regulator is provided with all the tools needed to manufacture meat and meat products that meet the highest global standards for food safety.

Outcomes and current status

The outcomes and current status of commercialisation have an impact across the entire industry and have enhanced its status as a supplier of safe meat both globally and at home. With the technology continuing to be developed and applied in new areas, the full potential from the application of this technology is yet to be realised.

Economic

In purely economic terms, the value of predictive microbiology can be estimated from the value of the trade that it protects. Without the market confidence instilled by this approach to scientifically-based risk management in the industry, it is possible that additional, potentially-costly controls may have been required by domestic regulators or importing countries. It is also possible that trade disruptions may have occurred potentially resulting in loss of access to a particular market and flow-on effects in others. We have therefore estimated the direct economic benefit based on the value of the process/product being protected by the application of predictive microbiology. The identified benefit derived by industry from predictive microbiology is the culmination of nearly 8 years of research with a total value of approximately $400,000.

Note that no estimate is made of the flow-on effect on financial viability and stability of the entire supply chain that would have occurred either had there been any loss of major market (such as those currently affecting the Canadian and US industries) or any meat-associated disease outbreak.

Use of predictive microbiology tools by the meat industry	Value ($m) per annum	
Providing predictive microbiology basis in new ECOs	Under evaluation	
Securing regulatory status of hot boned meat	15.0	*
Validating weekend chilling and carcase rewarming	30.0	**
Measuring the effect of refrigeration breakdowns	7.5	***
Validating regulation of the cooling of cooked meats	3.0	****
Providing scientific regulation for uncooked fermented meats	30.0	*****
TOTAL	**$85.5M**	

The basis for each estimate is the value of the sector. Without sound scientific regulation, market access of these sectors is made more fragile. Therefore, the value has been calculated as a percentage of the market that predictive microbiology is protecting, with, conservatively, 5% of the value of sales being used, except for fermented meats that has used 20% based on the effect of past disease outbreaks on sales in this sector.

* The hot boned manufacturing meat comprises 10% of exports to the US, i.e. around $300 million per annum.
** Weekend chilling accounts for almost 20% of carcases in the export sector that has a value of around $3 billion per year and satisfactory control ensures that these products are suitable for export markets.
*** The annual saving made by product that would otherwise be downgraded following refrigeration breakdown is estimated to be $7.5 million.
**** The estimated value of large, cooked, cured meats is $56 million per year.
***** Each year, the UCFM industry in Australia manufactures around 30,000t of product with a wholesale value ($5/kg) around $150 million.

Social

The social benefits of this work are clearly shown in the financial impact, particularly on rural and regional Australia, of the maintenance of market access for a high value export industry.

In addition, the role of protecting the wellbeing of vulnerable groups in the population, such as children and the elderly, has significant health impacts on the Australian community at large.

Commercialisation issues addressed

Pathways to commercialisation

Commercial application of these technologies has followed a pathway of:

- international scientific validation;
- industry/regulator acceptance;
- development of predictive microbiology tools;
- market testing; and
- dissemination to industry.
-

Intellectual property and patents

International acceptance of the technology and the regulatory approaches built on the technology has relied upon the generated intellectual property being in the public domain. Furthermore, there is commercial advantage if the technologies are applied in other countries – their regulatory systems are harmonised with our own (as the leader in this technology) and there is less likelihood of loss of consumer confidence due to problems in the domestic market of importing countries.

Skills and business knowledge

Both industry and regulators need to understand the principles of the technology so that it can be applied correctly. An upgrading of skills is required, but this can be gained through short courses and seminars rather than extensive retraining. The technology needs to be incorporated into a quality management framework to gain the greatest benefit, and this can sometimes pose the greatest challenge to the skills of industry and regulators.

Capital and risk investment

These technologies result in the development of 'knowledge products' that require negligible capital investment.

Business and scientific regulatory issues

Businesses and regulators need to gain confidence in the technology and this is addressed through international peer review and cooperative development of structures and rules that allow the technology to be applied.

Research and market linkages

A critical mass of world-leading researchers in this area has been crucial to the development and international acceptance of the technology.

Factors determining success

Three critical success factors:

- World-class researchers with international linkages
- Strong cooperation between industry and regulators
- Outcomes-based regulations and industry quality systems

RURAL INDUSTRIES R&D CORPORATION (RIRDIC)

The Rural Industries R&D Corporation has specific roles in the management of R&D programs for the encouragement of innovative technologies from investment in research for small and emerging industries, and on cross sectional and national interest issues. It is of particular interest in respect to the encouragement of innovative technologies and entrepreneurship and commercialisation pathways in those areas. Examples of facilitation of research results from RIRDC investments are set out below.

RIRDC Example 1: Canola Industry Development

RIRDC invested in production research to develop canola as a broadacre crop. Canola now a mainstream grains industry of up to 2.4 million tonnes per year with an industry value of more than $650 million pa and major exports.

RIRDC Example 2: Coffee Harvester Breakthrough

RIRDC helped develop a mechanical harvester which enabled local producers to compete with hand-picked product from the Third World. Production increased from 200 tonnes in 1998 to 400 tonnes in 2002, and is expected to exceed 1600 tonnes by 2008. The forecast farm gate value of production is expected to exceed $10 million by 2007.

RIRDC Example 3: Rice Site Selection and water use efficiency

The development of electromagnetic soil mapping technology (EM31) has enabled producers to identify leaking soils and to exclude production from these areas. Adoption of this technology by most producers in the industry has resulted in a reduction of water use of up to 3.5 megalitres per ha. Estimated returns enabled by the high rates of adoption of this innovative technology include a benefit/cost ratio of 100:1 and return on investment of 81%.

The very high grower adoption rates of this technology has enabled significant enhancement of grower returns. Additionally, several commercial companies have been established specifically to provide this service to the industry leading to increased rural and regional profitability and economic opportunities and a strengthened the 'rice industry cluster'.

RIRDC Example 4: New Chicken Vaccine

RIRDC support for the development of a live vaccine for a chronic respiratory disease which covers more than 40% of the global live vaccine market for this disease and its widespread use in Australia has significantly reduced losses and enabled financial returns to industry.

RIRDC Example 5: Pioneering Asian Food industry development

RIRDC initiated a National Workshop in July 1993 and managed projects on all aspects of production and handling. Investment in this research has enabled an increase in the value of the Australian Asian Foods industry from $50 million in 1994 to $136 million 200 and an increase in grower numbers from 679 to 1,675.

RIRDC Example 6: Improved Olive Quality & Yield

RIRDC research investment has facilitated the development of this industry in Australia and enabled higher product quality and improved crop yields. The industry has grown to produce an estimated 1,500 tonnes of product in 2003. This figure will grow rapidly as the 8 million trees planted in Australia during the last 10 years come into production.

RIRDC Example 7: New Fodder Varieties

RIRDC has invested in R&D for the fodder industry enabling the development and commercialisation of three new oaten hay varieties. Industry exports of oaten hay expanded by 200% in ten years, including as a result of the RIRDC investment due to improved product quality and a longer growing season.

RIRDC Example 8: RIRDC Rural Women's Award

Under this program winners receive bursaries which have been used for regional and personal development, including export activity. This has enabled more women to attain leadership positions in their industries. RIRDC winners have broken new ground such as:

- Exporting salmon into Japan;
- olive oil into China, plums into China wildflowers into India and wine into Hong Kong and Singapore;
- Taking out the country's top wine and cheese awards; and
- Designing high quality all Australian wool fashion;

RIRDC Example 9: Improved Rice Varieties and Linkages to Water Use Efficiency

RIRDC has invested in research to improve rice industry productivity and water management. 100% of rice varieties currently used in the industry have come from the RIRDC Rice Program. These varieties combined with other technologies enabled industry to improve yields per megalitre by 87% while simultaneously reducing water use by 45%.

RIRDC Example 10: Chicken Diet Improvement

RIRDC funded R&D into improved understanding of amino acid digestibility in chicken diets has resulted in significant reductions in feed costs of $2.5m pa. Benefit to cost ratios from the research investment are estimated at 69:1 with a rate of return on investment of 93%.

RIRDC Example 11: New Fodder Production System

Development of lucerne "Haymaker" best practice system has enabled an increase in the gross margin per hectare by around 30%. Return on the research investment is estimated at a benefit to cost ratio of 11:1 with a rate of return of on investment of 114%.

RIRDC Example 12: New Pasture Seeds Varieties

Nine new varieties of six new pasture species have been developed and commercially released. Most have generated 8-10% higher seed prices for growers through improved yields and quality. Benefits to cost ratios are estimated at 5:1 and the rate of return on investment of 28%.

RIRDC Example 13: Potential for gains from trade liberalisation

RIRDC research has demonstrated the large benefits to be gained from trade liberalisation and identified solutions to achieve reform. Better outcomes for Australia in world trade negotiations are a source of potential benefit. The research is valued internationally and domestically by government and industry organisations. Studies show the benefit to cost ratio of this research to be almost 90:1.

Section 4: CONCLUSIONS

The Committee has sought the views of the Rural R&D Corporation Chairs' Committee on aspects of technological innovation and related issues and on examples of successful Australian innovations.

This submission has provided the views of the Chairs Committee as requested and has presented the Rural R&D Corporation framework, individual corporations operating with the framework and successful technological innovations facilitated by them, as appropriate examples of successful technological innovations. This conclusion highlights a number of aspects of the submission.

The Rural 'R&D model' is an important part of the Australian innovation system and the largest program in the Australian Government's Agriculture, Fisheries and Forestry portfolio. The RDC model type arrangements have a strong track record of success from over 20 years of application and in this time it has proven to be highly successful in encouraging industry involvement in and facilitating outcomes from investment in rural innovation.

RDCs operate under unique co-investment processes in partnership with their principal government and industry, and other stakeholders. This activity concentrates on the management of an integrated set of strategically directed activities designed to keep our rural producers at the forefront of global competitiveness. In turn this will enable them maximise the sustainable returns to their rural industry constituents and the nation.

To progress these aims RDCs invest in and manage a wide range of activities to effectively integrate efforts across the innovation spectrum and within the framework of Australia's pluralistic system. While RDCs have a comprehensive brief, it is nonetheless centred, as indicated, on enhancing commercial benefits for its stakeholders over the short, medium and longer terms. This focus has been strengthened with the development of 6 of the 14 RDCs into industry owned companies which merge industry R&D, marketing and promotion functions. This ensures that these companies maintain a high level of commercial focus and are able to collaborate more expansively with other organizations at all levels of the innovation spectrum and through the industry value chain.

Their breadth of scope enables RDCs to be highly successful. They develop workable outcomes not only for investigating and developing innovative technologies but for ensuring that they are fully exploited. Because of the close symbiotic relationship they have with partners across the spread of activities and through the value chain, they keep their industries, those that work with them, and those that benefit from them, 'in the game.'

As a result they deliver considerable benefits for their industries and the nation.

Attachment A

RURAL R&D CORPORATION INCOMES AND EXPENDITURES 2003- 04

The table below sets out, for each of the organisations operating under the framework, the contributions received from industry and the Commonwealth, and their expenditures, for 2002/03.

(In interpreting these figures it should be noted that the figures do not necessarily add up horizontally across t table, principally because of the influence of reserves and other revenue sources e.g. voluntary contributions a interest earned. It should also be recognised that specific program funding is included in Commonwealth fundi figures for some corporations).

R&D CORPORATIONS/COMPANIES	INDUSTRY CONTRIBUTION ($M)	COMMONWEALTH CONTRIBUTION ($M)	R&D EXPENDITURE ($M)
AUSTRALIAN WOOL INNOVATION	42.74	14.12	55.84
AUSTRALIAN PORK LIMITED*	4.03	4.60	9.20
AUSTRALIAN EGG CORPORATION*	0.86	1.31	2.69
COTTON RDC	2.58	4.77	12.62
DAIRY AUSTRALIA*	15.35	15.35	31.48
FISHERIES RDC	6.54	17.72	28.10
FOREST AND WOOD PRODUCTS RDC	3.87	3.12	8.43
GRAINS RDC	68.78	42.36	124.00
GRAPE AND WINE RDC	7.19	6.87	14.23
HORTICULURE AUSTRALIA LIMITED*	29.95	28.38	57.25
LAND AND WATER RESOURCES RDC	-	12.24	25.64
MEAT AND LIVESTOCK AUSTRALIA*	32.78	32.78	62.60
SUGAR RDC	5.31	5.19	8.91
RURAL INDUSTRIES RDC	2.36	14.88	22.85
TOTAL	**222.34**	**203.69**	**463.84**

*Calculations for companies, with the exception of AWI, complicated by market/promotion/policy interests. Estimates for R&D expenditure derived from R&D expense or identified spend, with admin/corporate services costs calculated on a pro rata basis.