Combined Submission to the Productivity Commission Research Study into Science and Innovation in Australia

28 August 2006

CRC for Beef Genetic Technologies

CAST CRC

CRC for Innovative Dairy Products

CRC for Forestry

CRCMining

CRC for the Australian Poultry Industries

The Australian Sheep Industry CRC

Vision CRC

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1 Introduction

The Productivity Commission Research Study into Science and Innovation (the Study) is a timely and welcome opportunity for public comment on the impact of publicly-funded science and innovation on Australia's economic, social, environmental and industrial productivity and prosperity.

The group of CRCs contributing to this submission (the Group) is pleased to provide input to this Study. The Group regards this as an important opportunity to highlight several aspects of the economic, educational and social contribution of CRCs and their operating environment, which may not previously have been brought to the attention of the Australian Government.

The Group is composed of:

- CRC for Beef Genetic Technologies (Beef CRC)
- CAST CRC (CAST CRC)
- CRC for Innovative Dairy Products (Dairy CRC)
- CRC for Forestry (Forestry CRC)
- CRCMining (Mining CRC)
- CRC for the Australian Poultry Industries (Poultry CRC)
- The Australian Sheep Industry CRC (Sheep CRC)
- Vision CRC (Vision CRC)

In preparing this submission, the Group has referred to the Terms of Reference of the Study:

The Commission is requested to:

1. *Report on:*
    - *the economic impact of public support for science and innovation in Australia and, in particular, its impact on Australia's recent productivity performance;*
    - *whether there are adequate arrangements to benchmark outcomes from publicly supported science and innovation and to report on those outcomes as measured by the benchmarks.*

    The analysis should cover all key elements of the innovation system, including research and development, taking into account interaction with private support for science and innovation, and paying regard to Australia's industrial structure.
2. *Identify impediments to the effective functioning of Australia's innovation system including knowledge transfer, technology acquisition and transfer, skills development, commercialisation, collaboration between research organisations and industry, and the creation and use of intellectual property, and identify any scope for improvements;*
3. *Evaluate the decision-making principles and programme design elements that:*
    - *influence the effectiveness and efficiency of Australia's innovation system; and*
    - *guide the allocation of funding between and within the different components of Australia's innovation system;*

and identify any scope for improvements and, to the extent possible, comment on any implications from changing the level and balance of current support;

Report on the broader social and environmental impacts of public support for science and innovation in Australia.

The Group endorses the submission to the Study already presented by the Co-operative Research Centres Association (CRCA). Throughout this submission, specific reference is made to key recommendations from the CRCA which are supported by the Group.

The CRCs contributing to this submission strongly express their willingness to engage further with the Productivity Commission (PC) in the course of this Study. They seek the opportunity to invite the Study's Commissioners and team members to visit relevant sites that will enhance their understanding of the key messages of this submission, and to participate in public forums or roundtables that are conducted in the later stages of the Study.

CRCs are uniquely positioned to deliver national benefits, as they are agile organisations, embedded in industry, which cut across the boundaries of sectors, educational institutions and states to make a positive impact on Australian industry. They take a holistic approach to addressing industry issues through creative, cut-through research and development (R&D) activities. A key to their success is the renewal process that forms part of their lifecycle, which prevents them from becoming moribund.

The CRC model also specifically addresses the comparatively low level of R&D and innovation-related expenditure being undertaken by Australian industry. The involvement of industry through the model assists in creating a better developed innovation culture within industry. It also provides a more direct link between publicly funded R&D and commercial outcomes, and ensures that the type of science and innovation being conducted reflects the industry need.

The way in which the outcomes from CRCs are measured is also addressed in this submission. There are a number of impacts created by CRC activity that may not be recognised by current measurement processes.

This submission is in two parts: the first seeks to identify the economic, social, educational and industrial benefits delivered by the CRC program, which are not captured by traditional economic impact methodologies. The second part makes recommendations about improvements to the program, which would ensure that the national value already derived is magnified by the removal of structural impediments.

The context for the CRCs contributing to this submission is shaped to a large degree by the specific composition of partners and supporting partners in each case. Appendix A includes a list of all participants in these CRCs, as this information helps to describe the landscape in which each CRC operates.

2 The Impact of Cooperative Research Centres (CRCs)

2.1 The unique relationship of CRCs with industry

Due to their unique combination of commercial and research partners, CRCs provide a link between industry and the research, development and education (RD&E) community that is not replicated by any other organisation in Australia. To appreciate the raft of benefits arising from this link, it is essential to consider their qualitative impact, as well as their quantitative aspects.

Integration, Coordination and Accessibility

CRCs operate with a national and international reach that is unique and necessary in successfully uniting industry to address issues important to its collective future. Most businesses have limited resources they can devote to RD&E activities and as such prefer to put these funds into one place.

CRCs provide an excellent mechanism to integrate research and delivery efforts between industry sectors and different organisations and institutions. This is seen as one of the most effective and productive roles of a CRC. The success of many RD&E activities has come from carefully aligning the strategic imperatives of different major organisations to deliver a well coordinated program. The resources available to a CRC through national and international alliances are considerable. CRCs are one of the few structures where integration across State and institutional boundaries is actively practiced and funded.

CRCs are critical to specific industry sectors and drive cooperation within sectors. Some industry members would not ordinarily communicate with each other if not for CRCs. There is benefit for Australia in this interchange. CRCs do more than just conduct research: they are a dynamic force that provides the ‘glue’ for the sector, with industry conferences and training programs a secondary but vital aspect of the CRCs’ work. For example:

- the Poultry CRC brings the three major chicken meat processing companies together to address common national issues
- the Mining CRC unites major competitors both on a national and international stage
- the Beef and Sheep CRCs bring together producers, feedlotters, processors, and retailers from all sectors of their industries, none of whom had ever collaborated prior to the existence of CRCs.

This unprecedented cooperation drives efficiency in dealing with national problems and helps create critical mass both within and across industry sectors. CRCs provide a centralised, independent and focussed forum for all levels of industry to interact on issues.

CRCs are intimately linked to the marketplace and therefore respond to industry issues with agility. Just as CRCs have the benefit of picking and choosing the best talent from throughout Australia and the world to contribute to its RD&E programs, so too do CRCs coordinate expertise from across industry to deliver high quality and well targeted inputs to CRC RD&E activities. Through such activities and through involvement in core research projects, CRCs also serve to link companies across the value chain, thereby speeding up commercialisation of technologies developed through CRC research.

Small and medium enterprises

The interaction of industry fostered by CRCs is particularly important in relation to small and medium enterprises (SMEs), which would not ordinarily have the opportunities to access the range of R&D conducted in national research institutions. The technology transfer, education and training provided by CRCs is especially valuable to SMEs.

SMEs benefit from the work undertaken by CRCs as each SME's own general lack of funds available to finance research means that without the CRCs, SMEs tend to concentrate on the short term. While SMEs stand to gain enormously from CRC involvement, there exist some disincentives to SME support of CRC activities, including the fact that unincorporated businesses can not currently claim the R&D tax concession. As SMEs in some industries, particularly agriculture, are predominately unincorporated, this has a direct impact on the engagement of and benefits derived by SMEs from the CRC Programme.

Cross-Industry Partnerships

The uniquely effective coordinating role played by the CRCs also crosses industry boundaries. For example, the Beef and Sheep CRCs' post-graduate education programs are run collaboratively to encourage post-graduate students to develop a professional network that will serve them well beyond their university days. Thus CRCs deeply embed students within their industry and deliver graduates that are immediately industry-ready and commercially aware. These two CRCs also collaborate in particular scientific disciplines including meat science and bioinformatics. Depending on their longevity, these CRCs intend to collaborate in industry delivery programs as well as "adoption science" that specifically targets industry uptake of technologies.

Flexible models of commercialisation

The intimate link between CRCs and their respective industry sectors enable them to be highly responsive to issues which are important to industry, and to identify where benefits from new technologies will be derived. One outcome of this is the development of a range of commercialisation models that have been applied within the CRC environment.

As outlined further in section 3.5, these models have included:

- selling of training packages to industry, which facilitate the commercialisation process
- use of industry intelligence mechanisms to share benefits of the uptake of particular innovation
- use of exclusive licences
- direct application of technology unencumbered by an IP or trademark requirement.

Further development of the commercialisation process in Australia is critical as it forms a link to industry's realisation of the benefits of innovation. The creation of strong commercialisation processes that apply to the Australian environment will assist in promoting those benefits, and work to encourage industry to further invest in R&D.

Case Studies

Improved cooperation in the poultry industry

Until the establishment of the Australian Poultry CRC, companies in the chicken meat industry viewed each other only as competitors. The big three companies, Inghams Enterprises Pty Ltd, Bartter Enterprises Pty Ltd and Baiada Poultry Pty Ltd together control over 80% of chicken meat production in Australia. These companies have had a long history of struggle to capture and maintain a share of a highly competitive market.

However, the three companies realised that by becoming supporting participants in the CRC, their common needs in terms of bird nutrition, health, disease control, welfare and environmental issues could be met without compromising their commercial independence. Common problems and different experiences are now shared for the benefit not only of these three companies but of the entire industry. Dr Jeff Fairbrother, Chair of the Australian Poultry CRC and former Executive Director of the Australian Chicken Meat Federation with over 35 years of experience in the industry, summed this up in December 2005 by saying that, because of the CRC, the "big three chicken meat companies were now sitting at the same table and talking".

Other organisations and sectors within the egg industry and chicken meat industry have followed suit since realising the benefits of industry cooperation and communication. For example, free-range egg producers in Queensland are now willingly becoming involved in helping with research into assessing and controlling environmental impacts arising from egg production, a situation which would have been unlikely only a few years ago. In addition, other companies in the chicken meat industry are becoming involved in CRC research, for example, Hazeldene's Chicken Farm in Victoria. Ultimately, both the egg industry and the chicken meat industry have become aware that by working together they can defeat problems common to both because, as is often said, "disease knows no boundaries".

Integrating wool and sheep meat industries

Prior to the commencement of the Sheep CRC the wool and sheep meat industries conducted their R&D activities as two separate operations with little, if any, overlap. The Sheep CRC has played a major role in integrating the activities of wool and sheep meat research by focusing on the sheep and the wool-meat interface. The CRC's Board has representatives from the peak industry councils WoolProducers, Sheep Meat Council, Australian Wool Innovation, Meat and Livestock Australia and Australian Meat Processors' Corporation.

This is the first organization in the sheep industry to have such a balance of wool and meat industry interests and the first time that meat processors and producers have worked together in close cooperation on R&D initiatives. Current investment by Meat and Livestock Australia and Australian Wool Innovation in five major sheep CRC projects has cemented a close working relationship between wool and meat industries and created a better understanding of the benefits for sheep producers resulting from better management of the wool/meat interface.

CAST's engagement of SMEs

The CAST CRC has the Australian Die Casting Association and the Australian Foundry Institute (Queensland Division) as participants. These organisations have many SME members. The technology needs of SME manufacturing companies are different from the larger corporate entities. SME manufacturing companies tend to have limited resources and technological solutions that need to be met within a timeframe of months rather than years.

To engage these SMEs, CAST has developed the Best Practice Program. The Best Practice Program combines elements of technology transfer and focused short term research projects to provide the technological solutions required by companies. CAST researchers

develop or access the technology package for the companies and support the companies to implement the solution. This has led to quantified savings, new capability and improved product.

The program also builds capability within companies. Integration with existing equipment, processes and company culture is required for new technologies to be successfully introduced into companies. The Best Practice Program is involved in all these elements. One aspect of the process includes the aspect of up skilling the companies to support them to develop an innovative culture that continues beyond the life of a single project.

Issues in Summary

- CRCs play an invaluable role coordinating industry and research participants across institutional, geographical and sectoral boundaries.
- CRCs provide the glue that binds the industry and are responsive to changing industry issues.
- CRCs are more accessible to SMEs than traditional research providers, although limitations on R&D tax concession claims can also act as a disincentive.
- CRCs drive cooperation between industrial competitors to address common national problems.

Recommendations

Recommendation 1

The science and innovation policies of the Australian government should continue to support and foster further development and expansion of the CRC Programme.

Recommendation 2

R&D tax concession rules should permit unincorporated SMEs to claim in relation to legitimate CRC engagement.

2.2 CRCs as drivers of industry-relevant education and training

A highlight of CRCs is their contribution to industry-relevant education and training. CRCs have contributed to building skills through conducting or establishing training programs, including professional education. In doing so, they also have a significant role in leveraging products through industry, and in the development of industry standards.

In providing education and training to industry, CRCs have the advantage of being able to cut across both state boundaries and educational levels in developing and delivering programs. CRCs are in the unique position to be able to develop programs across the full spectrum of education and training environments, including secondary schools, TAFE colleges, universities, the factory floor, and directly to SMEs and rural operators. They coordinate expertise from across industry to deliver training courses which address the current needs of industry. This is a critical contribution to building the national skill base, with up to 80% of CRC post-graduate student researchers finding employment directly in industry or with industry providers. CRCs are developing industry skilled people with an innovation focus.

Industry-specific Training Courses

Beyond the training that the fertile research environment of CRCs themselves have provided, CRCs have been involved in delivering external specialised training for their industry members, the successes of which have often gained international admiration and interest in exporting these programs abroad. Examples of success in this area include:

- the Avian Health Online program developed by Poultry CRC which has generated interest from the University of Georgia
- a molten metal safety course, developed by CAST CRC, which has found popularity throughout the Australian industry and also is currently being sought by a US association. CAST CRC has also been successful in delivering specialised training to Boeing Australia, utilising the expertise of the Commonwealth Defence Science and Technology Organisation
- professional education courses for eyecare practitioners, delivered at both a national and international level by Vision CRC. The courses leverage products being developed by the CRC to enhance the services delivered by eyecare professionals and have delivered sales improvements of around 66% to the SMEs. They provide significant beneficial social impacts, through improved treatment of eye conditions around the world
- cross-sectoral cooperation between Beef and Sheep CRCs to promote post-graduate opportunities in the sheep and cattle industries.

These examples and others are expanded in the case studies below.

Addressing the skills shortage and raising industry standards

There has previously been a focus by industry on academic education for workplace skills and this still plays an important role. CRCs have also established formal University and Vocational Education and Training (VET) programs in order to address the needs of industry. Examples include:

- the establishment by the Beef CRC of a Chair in Meat Science at the University of New England, specialist undergraduate courses in meat science and feedlot management, and a matching meat science program. The latter addresses skill shortages in the beef industry by delivering training from post-graduate level through

to workers on the meat works floor, which the 1993 Industry Commission Report noted had the lowest levels of skills and training of all the industry sectors surveyed

- the highly successful establishment of a Chair in Wool and Sheep studies at the University of New England by the Sheep CRC
- the establishment by the Poultry CRC of two industry-specific undergraduate courses at the University of New England
- the sustainability by the Mining CRC of the mining program at the University of Queensland, with the support of significant funding from its industry partners.

As these examples demonstrate, the CRCs make a significant contribution to the Australian Qualification Framework by assisting with the continuous improvement of industry standards. This is particularly the case in some industries that have traditionally had low skill levels, such as meat processing.

Similarly, the impact on rural industries is very significant. The Department of Agriculture, Fisheries and Forestry's (DAFF) submission to the House of Representatives' Agriculture, Fisheries and Forestry Committee 2005 inquiry into rural skills, training and research identified a number of areas of concern with the current system of agricultural education, training and research. This included noting concerns about the need for increased industry engagement, increased collaboration between producers, representative organizations, the training industry and other key stakeholders and the promotion of agribusiness and careers in agriculture. All of these issues are currently addressed directly through the work of CRCs and these successes could readily be expanded to further remedy DAFF's concerns, should such expansion be supported by Government.

Highlighting and drawing upon the skills of a range of industry-focused educators and researchers to deliver optimally designed education and training provides rewarding and tangible outcomes for the CRC network.

Post-graduates

CRC industry partners often cite the development of post-graduate scholars with industry focus through the CRC Programme, and their potential to then move directly into industry, as a major factor behind their involvement. Their experience in CRCs makes these post-graduate students more industry-ready than those who have graduated directly from university.

The Forestry CRC has experienced its PhD students as being highly sought after by industry. There are many examples of industry staff being allowed time-off from work to undertake a PhD with the CRC, students nearing completion being offered employment with industry (with time allowance to complete their thesis) and recently graduated students being offered excellent industry-based jobs.

In part this is due to the experience gained by the close alignment of CRCs to current industry issues, but also because CRC post-graduates have a direct interface with industry that allows them to build effective networks nationwide. This networking is particularly useful for professionals with isolated roles in low-volume industries, where having a strong network can build industry commitment. Recently CAST saw two of their PhD students taken directly into industry due to the networks and wealth of experience acquired through the Programme.

Impediments to CRCs' activities

As outlined above, CRCs make an enormous and often undervalued contribution to the skills and training industry needs to retain a competitive edge. However, there are several barriers to building on past successes and expanding this important role.

Impact of the skills shortage

The skills shortage facing Australia has had an effect on the ability of CRCs to attract and

retain research talent. The buoyant employment market and wealth of opportunity in various industries has resulted in a lack of industry loyalty among PhD students, who move to where their research attracts significant scholarships and further prospects in industry. Forestry CRC has experienced difficulties in attracting recent undergraduates to undertake post-graduate study, as the employment market means they are being lured by the attractive salaries on offer by industry. The Forestry CRC's experience is that its PhD students are highly sought after by industry. While this is a positive in terms of graduates being offered excellent industry-based jobs, there are also examples of students nearing completion being offered employment with industry with time allowance to complete their thesis. In this case, the CRC does not capture the benefit of the work it has supported.

In the engineering field, the gap between the value of post-graduate research scholarships and starting salaries in industry has increased dramatically over the last five years making post-graduate study a much less attractive career choice. For example, CAST CRC, along with Materials Science and Engineering departments generally, is having difficulty in attracting suitable PhD students due to insufficient interest in pursuing post-graduate study. The Mining CRC cites difficulty in retaining researchers where the industry itself offers very attractive starting salaries.

This combined with the barrier of finding funding for tuition fees for overseas students means that the number of post-graduate students will decrease. Lower tuition fees for overseas students would immediately reverse this. Making it easier for bright, high quality overseas students to undertake research-based PhD programs in Australia provides a national benefit, arising from those that wish to stay and from the expanded global network of colleagues that it creates when they decide to return to their home country.

Impact of CRC life cycle

Although some post-doctoral researchers have managed to forge a career through research work with CRCs, the limited life of CRCs makes it difficult to sustain a career over a series of short research engagements. A higher calibre of scientist can be retained with greater security of tenure, thus the longer the term for which CRCs can offer research opportunities, the greater the competitive advantage they hold in developing high-quality research.

As an example, Vision CRC will have had 65 PhD students involved in its research work over the course of its funding cycle. This is a significant engagement of Australian scientists, but as the CRC is unable to retain these personnel due to its scheduled conclusion, time and financial resources (including revenue from intellectual property (IP) developed by Vision CRC) have been dedicated to ensuring the successful redeployment of these researchers at the conclusion of the funding period. Strategies developed by CRCs to support this transition include early planning for the transfer of funds and supervision back to the universities, while wherever possible keeping the industry links nurtured by the work of the CRC.

Case Studies

Avian Health Online

In 2005, the Poultry CRC, in collaboration with the University of Melbourne, funded the development of Avian Health Online (AHO). The online post-graduate courses within the AHO project are designed to satisfy the global demand for veterinary scientists with formal specialist qualifications in Avian Health. Avian Health Online currently comprises:

- Post-graduate Certificate in Avian Health (2 units)
- Master of Veterinary Studies (Avian Health) (6 units).

These courses enable professional veterinarians to continue working while studying part-time. The Learning Units offered include:

- Poultry Industry Fieldwork
- Pathology and Diagnosis of Disease
- Microbiology and Serology for Disease Control
- Food Safety
- Public Health and International Trade
- Poultry Production and Financial Analysis Skills
- Research Dissertation.

Towards the end of 2005, the University of Georgia approached the University of Melbourne to discuss the establishment of an international avian health online course. With the consent of the Australian Poultry CRC, a memorandum of understanding was agreed between the two universities in early 2006 to achieve this objective.

Molten Metal Safety Course

Die shops, foundries and smelters by their very nature present a wide range of workplace safety issues that need to be properly managed. Appropriate risk assessments, engineering designs, training, maintenance, monitoring and control are required for a range activities in the cast house environment. One such risk is working with molten metal.

The dangers of working with molten metal are known to the industry. However, the dissemination of industry best practice across the many companies involved with handling molten metal has been greatly improved through the development and delivery of a course by the CAST CRC. The knowledge and experience resident in the detailed course has benefited the whole industry from large aluminium smelters through to small die casting shops.

The course is structured on TAFE Engineering Competencies as part of an accredited training package suitable for a range of production staff.

The international aluminium industry has recognised the quality of the CAST molten metal course which will shortly be presented to companies in the United States as part of an international education collaboration between the CAST CRC and the North American Die Casting Association (who is affiliated with the Australian Die Casting Association: a core participant of the CAST CRC).

Aircraft Corrosion Course developed for Boeing Australia

The CAST CRC project managed, developed and delivered a two-day training program on Aircraft Corrosion to Boeing Australia. The education model employed has also been successfully utilised in the die-casting and light metal industries. The success and ease of implementation of the model revolves around the intimate industry, research and academia networks inherent in the CRC.

The Aircraft Corrosion course utilised the expertise of DSTO research staff and the skills of senior teaching academics. The blend of technical detail and adult learning principles coupled with previous project management skills associated with shop floor course delivery produced a well received and highly regarded course.

The development of this course had the additional benefit of capturing knowledge held by a senior DSTO expert with a lifetime of experience in the corrosion of aircraft materials, and making this knowledge available so that further industrial and economic benefit could be obtained.

Professional Development for Eyecare Practitioners

The eyecare market is directly influenced by the knowledge and skills of eyecare practitioners. In its various forms, Vision CRC has taken a unique approach to expanding the market through education. The Presbyopia Education Program (PEP), for example, is a collaborative project between the CRC and Essilor International to deliver education about

presbyopia (the age-related inability of the eye to focus on near objects) and its treatment to Asia Pacific eyecare practitioners and educators.

Many eyecare practitioners in the region know little about the condition or its effective treatment with the latest vision correction devices. CRC education programs are changing this, and they are a vital component of the development of the market in Asia. One of the most important innovations of PEP is that it targets both practitioners and educators. While improving the skills of practitioners has an immediate effect on the eyecare they provide, improving the knowledge and materials of educators has an ongoing effect on all the future practitioners they teach.

Education Programs specifically developed by Beef CRC

The innovative Meat Science Program for Australia was initially developed by Beef CRC at the University of New England, but is now delivered nationally by 6 universities. The CRC achieved funding for a new Chair in Meat Science at UNE as the basis of development of the program. The Meat Science undergraduate and post-graduate courses have also been modified and customised for use as training materials for Meat Standards Australia (MSA) graders and meat processors, TAFE college modules, Agricultural College course materials and into the agricultural high school syllabus.

Meat workers were previously identified by the 1993 Industry Commission as the least skilled workers in Australia and the Meat Science Program has achieved enormous improvement in the national industry standards for this sector.

Academic and research positions funded by Mining CRC

Mining CRC funds several full-time academic positions and numerous full-time research positions at its member universities. In 2005-6 the CRC funded three chairs: the chairs of mining engineering and mechanical engineering at The University of Queensland (UQ) and the chair of mining geophysics at Sydney University. In addition, the CRC funded a senior lecturer's position and a lecturer's position in mechanical engineering at UQ and a lecturer's position in mining engineering at UQ. It fully-funded a research scientist at The University of Newcastle and two senior scientists positions at Curtin University.

Sheep CRC: Hub and Spoke Model for National Delivery

At the commencement of the Sheep CRC all sectors of the Sheep Industry and the academic community recognised that sheep and wool education had been badly neglected for approximately ten years. The Sheep Industry represents export earnings for Australia of approximately $4.5 billion annually, yet no specialist training program was available anywhere in Australia. No university was prepared to take on the task of investing in courses with low student numbers. The Sheep CRC coordinated a national program to rewrite education resource material for all aspects of the sheep industry. With co-investment from Meat and Livestock Australia, Australian Wool Innovation and from the Australian Wool Education Trust, the CRC commissioned industry experts and leading academics throughout Australia to write lecture topics in areas of their expertise.

The result has been development of an up-to-date set of resource material covering ten full semester courses at undergraduate level. The courses are being delivered nationally through an innovative hub and spoke model. The University of New England at Armidale has taken responsibility for delivering all the material via distance education combined with residential schools for practical classes. Courses, using the same resource material, are also delivered through cooperating universities in Western Australia, Tasmania, Sydney and Melbourne.

This 'hub and spoke' model has overcome the issue of low student numbers at individual universities studying sheep production, marketing and processing. A national approach and a single source of resource material that is regularly updated mean that students can study sheep production throughout Australia using a model that is financially sustainable within

the current university system. Undergraduate student enrolments in these new sheep units have already exceeded the forecast demand.

The extensive resources material created for undergraduate courses also provides a very valuable resource for vocational training and many components are suitable for school level courses. The CRC and its partners are therefore investing in the adaptation of the undergraduate material for use in the vocational training and school areas. This integration of education delivery across university, vocational and school programs is unique to the CRC model.

Opportunities for post-graduate students from CRC involvement

In the early stages of both the Beef and Sheep CRCs it was always a challenge to find high quality post-graduate students, even when both CRCs were providing attractive scholarships. The two CRCs have combined forces to run an annual post-graduate conference and training program involving post-graduate students from both CRCs. The networking between students, made possible through the annual conference, and the perceived benefit of the training program by all students has helped to create a positive awareness of the post-graduate program and its value in career development.

Through close links with industry the post-graduates have found interesting and challenging employment opportunities at the completion of their degrees and this information has also provided positive feedback to students contemplating careers in the sheep and cattle industries. The success of this post-graduate training program has meant that over the last five years there has been a significant and steady increase in the level of interest in scholarship applications and particularly in the quality of the students applying. In response to the most recent advertisement for post-graduate scholarships the applicants outnumbered positions by approximately 2:1 and all successful candidates had first class honours.

Industry support for Forestry CRC role in Education and Training

The Forestry CRC has achieved a very high level of productivity with regards to publications and graduate and post-graduate students training. A number of prestigious awards and grants, together with the number of students which have been attracted from several countries abroad, bear testimony to the quality of the research and training outputs. The feedback from the industry indicated that the CRC is regarded as the prime source of post-graduates addressing their needs.

Issues in Summary

- CRCs make an enormous and frequently undervalued contribution to the Australian education, skills and training landscape.
- CRCs are unique in that their engagement in education, skills and training is across the full range of levels: secondary schools, TAFE and agricultural colleges, universities, factory floor, direct to SMEs and rural operators.
- CRCs contribute to education, skills and training both nationally and internationally, delivering significant economic and social benefits.

Recommendations

Recommendation 3

Ascribe economic and social value to CRCs' contribution to education, skills and training when assessing both individual CRCs and the achievements of the Programme overall.

Recommendation 4

Consider decreasing the financial barrier to universities that enrol overseas students who work through CRCs to deliver benefits to Australian industry.

2.3 International linkages created by CRC involvement

World class research organisations require international connections, and international collaboration is a measure of the maturity of the CRC Programme. International partnerships for CRCs occur through a range of means, including the need for research collaboration, international commercialisation opportunities, or the adoption of the CRC model itself abroad.

These partnerships raise numerous benefits for CRCs and Australian research generally, though often they can only be fostered where longevity of individual CRCs exists. Foremost among these benefits is the exposure to international models of R&D collaboration and the opportunity to continuously learn and improve. More often, however, the Australian CRC model is being imitated overseas.

In finding international markets for the technologies they have developed, CRCs have engaged in a variety of training programs internationally, usually through collaborations with industry partners and research institutions abroad. These ventures assist CRCs in developing revenue opportunities to increase their financial self-reliance and viability.

CRCs have also been extremely successful in attracting international partners and associates, through both industry and academic linkages. These alliances support exchanges of post-graduate students and research personnel working on collaborative projects and these exchanges result in publications and valuable research outcomes. Most of the CRCs contributing to this submission have at least one foreign contributor, and all have established strong international alliances.

These linkages also provide critical alliances for the industry participants within the Programme, exposing them to international innovation and R&D activities. From a competitiveness perspective, the ability of Australian industry to appreciate global activities and leverage them in the local market is a vital aspect of sustained economic performance. CRC collaboration internationally has also opened the door to a number of international companies with a view to licensing IP developed through the Programme.

These international linkages enhance Australian science and innovation in ways that are often intangible and hard to measure. Nevertheless the value they add should be recognised and appreciated.

Branding Australian R&D

International activity creates invaluable brand awareness around Australian innovation and R&D capabilities. Heightening this profile ensures Australia continues to attract top overseas talent to complement local researchers or to fill skills gaps where they exist. International research collaboration can open strategic markets not only for the CRCs and the technologies they develop, but also for the industries represented.

CRC activities draw interest from many researchers internationally, and CRCs receive numerous applications from foreign post-graduate students annually. The engagement of these students also helps to redress the shortage of PhD students in particular sectors.

Enhancing R&D quality

Collaboration with international research institutions can serve to improve the quality of Australian research by overcoming the limitations of critical research mass in Australia. For example, Beef CRC’s collaboration with US institutions in conducting gene expression research is overcoming the lack of essential but very specific expertise that is not currently available in Australia. The collaboration is aimed at developing Australian capability in the new fields of research as well as speeding up delivery of genetic and non-genetic options to improve beef herd productivity and profitability.

International imitation endorses the CRC model

Government funded collaborations on innovation occur worldwide, including well-documented examples in Japan, Ireland and especially Finland, where more than 20 years of high tech research funding has resulted in the global success of Nokia. However, the CRC concept is unique to Australia and its success has attracted worldwide interest.

The CRC concept itself has been exported to various parts of the world, with examples found in:

- the Canadian Department of Agriculture National Programs
- the Chilean Centre for Scientific and Technological Research in the Mining Industry
- the Austrian Kompetenzzentren-Program 'K-Plus' scheme.

Further variations of this model have been established in South Africa, Canada, France and Korea. Several of these examples are expanded further below.

Impediments to International Linkages

International activity for CRCs is critical to maintaining Australia's role in global R&D and bringing economic benefit to Australia. CRCs are however restricted in the use of their core Commonwealth funding to attract international research partners. This limits their ability to attract international partners and sell technology abroad.

CRCs are largely dependent on seeking alternative sources of funding for international linkages, such as the Department of Education, Science and Training's (DEST) International Science Linkage (ISL) grants. This means that once the CRC is successfully established, it then needs to embark on another round of competitive grant-seeking.

A portion of a CRCs core grant funding should be allocated specifically for the purpose of attracting international engagement. Alternatively, some DEST funds from the ISL scheme should be specifically made available to CRCs during their re-bid process to allow simultaneous application for CRCs and ISL funding. In this instance, if the CRC application was successful, the ISL funding would also become available.

Case Studies

Multinational collaboration

Light Metals Alliance

The CAST CRC has a number of international collaborations, however, the most significant of these is an international Light Metals Alliance formally established in 2002.

The Alliance involves similar organisations that have a strong industry focus. The members of this Alliance include:

- CAST CRC
- the Leichtmetallkompetenzzentrum Ranshofen GmbH (LKR) (Austria)
- CANMET Materials Technology Laboratory (Canada)
- GKSS Research Center (Germany), and
- Worchester Polytechnic Institute (USA).

These are research centres with established reputations for excellence, strong linkages with industry and are also a pivot point for a number other centres and universities within their country. For example, CANMET coordinates Light Metals collaboration with Canadian universities such as the University of British Columbia, McMaster, Toronto and McGill.

Of interest is that LKR is a K-Plus centre and the K-Plus program is modelled on the Australian CRC Programme.

This alliance supports collaborative projects for post-graduate students and research personnel, which have occurred between both researchers and industry participants. Such exchanges have resulted in publications and research outcomes of value to CAST's industry participants.

This collaboration has also opened the door to a number of international companies. At present, CAST is in discussion with a global company regarding licensing of a CAST technology where initial contact with this company was facilitated by one of the Alliance partners.

Wide scope of Vision CRC's international collaboration

Vision CRC is a collaboration of 30 of the world's leading groups in eyecare and vision research, education and delivery. By seeking out these leaders, capitalising on existing knowledge and integrating complementary expertise, Vision CRC is able to tackle world-scale research and development projects. International participants include: Anglia Polytechnic University, Department of Optometry (UK); Bascom Palmer Eye Institute, University of Miami (USA); Pennsylvania College of Optometry (USA); University of Houston, College of Optometry (USA); University of Waterloo, Centre for Contact Lens Research (Canada); Johns Hopkins University, Department of International Health (USA). Vision CRC has also successfully attracted collaboration with some of the world's largest ophthalmic companies, for example the contact lens projects conducted with CIBA Vision, a division of Novartis; and education projects conducted with Essilor through a Vision CRC Core Partner, the International Centre for Eyecare Education.

Imitation of the CRC model abroad

USA

Dr Larry Cundiff, the Genetics Research Leader at US Department of Agriculture Meat Animal Research Center, Clay Center, Nebraska has been widely quoted as indicating "Previous CRCs on Beef Production and Beef Quality have provided an enviable model that the whole world has followed and admired."

Further, Professor James Womack from the College of Veterinary Medicine, Texas A&M University and initiator of the International Bovine Genome sequencing project, has noted in a March 2004 supporting letter for Beef CRC that the "CRC model of an adoption pathway for technology from laboratory to commercial utilisation is the envy of most countries, including my own." Dr Cundiff in past years tried to establish a CRC-type approach in the USA but lacked the financial incentives required to induce change amongst potential research and industry collaborators and hence pursued development of essential phenotypes within USDA only.

Canada

The Canadian beef industry had to be completely restructured following the BSE (mad cow disease) incidences there. Following a Canadian delegation to Australia, Professor Bernie Bindon from the Beef CRC has now twice visited Canada to oversee the implementation of a CRC model across all meat-animal species in Canada.

South Africa

The CRC model was used to establish a collaborative project between Australia and South Africa in 1999-2000 in relation to the local beef industry. This project involves collaboration between two institutions from the South African Agricultural Research Council, two Provincial Departments of Agriculture, the National Department of Agriculture and several beef industry organisations. It has achieved outstanding success in a very short time, receiving national recognition in South Africa.

The model has been extended by South African governments to other provinces and to other agricultural industries, with a recommendation from the National Department of Agriculture that the project's model and methodologies be used to underpin a national strategy to commercialise South Africa's emerging farmers across agricultural sectors.

Austria

Drawing from the Australian CRC system, Austria has established a Kompetenzzentren-Program (Kplus, K_ind and K_net). Encompassing a 'new culture of collaboration', 17 national Kplus centres work to develop links between research and industry in the same vein as CRCs, while 28 K_ind and K_net centres operate under the leadership of industry organisations to develop research in more technologically-oriented fields.

Chile

Chile currently has nine Regional Research and Cooperative Development Consortia operating with the objective of drawing together the skills of industry and research institutions to carry out research on topics that are economically and technologically relevant to the regions where they are based. These centres are modelled on the Mining CRC and funded by regional and national governments and from contributions made by public and private companies. Topics of research include aquaculture, mining, nutritional genomics and Patagonian ecosystems.

Issues in Summary

- The international activities of CRCs create an invaluable profile and brand awareness of Australian R&D and innovation, and promote the exchange of key personnel and technology transfer.
- International linkages directly address some inherent limitations of Australian R&D activities, such as critical research mass in very specialised research areas.

Recommendations

Recommendation 5

Value should be ascribed to the international activities of CRCs when assessing both the Programme and individual CRCs. This value should be assessed in terms of benefits returned to Australia.

Recommendation 6

Improve access to international partners by adjusting the funding model for CRCs in relation to DEST's International Science Linkage program.

3 Enhancements to the CRC Programme

3.1 The CRC business model

There is much evidence to suggest that the success of a CRC in efficiently delivering on its objectives is significantly influenced by its structure. Newly formed CRCs do not usually appreciate the impact of the company structure they select on future operations.

Key considerations

The CRC Programme Objective is:

*to enhance Australia's industrial, commercial and economic growth through the development of **sustained, user-driven**, cooperative public-private research centres that achieve **high levels of outcomes in adoption and commercialisation**.*

To maximise their ability to achieve this Objective, CRCs need to have:

- effective governance, including board members with appropriate skills. CRCs must have the ability to attract skilled board members with appropriate remuneration. Experience has shown that CRCs work most efficiently where board members are independent and non-representative, assisting in decision making and preventing vested interests taking control
- simple management and administrative processes and IP ownership arrangements that enable a quick response to commercialisation opportunities
- flexible project management systems to respond to changes in market requirements.

The following factors also impact on the effective operation of CRCs:

- commercialisation often takes longer than the life of a single term of a CRC
- capital gains tax (CGT) is an impediment to commercialisation and should be eliminated from the CRC model
- commercialisation income needs to be reinvested into further research, both to meet the requirements for tax exemption and to create an incentive for CRCs to commercialise the outcomes of their research.

The above conditions and the operation of CRCs in Australia suggest that the following features characterise an efficient operating model. The CRC should:

- be an incorporated company limited by guarantee
- have a tailored board with appropriate skills
- own the IP legally and beneficially
- be a not-for-profit company
- reinvest income into R&D
- be tax exempt.

Having a standard CRC business model would also reduce the administrative costs associated with establishment of CRCs, including legal and taxation costs.

In the 2004 selection round, two template Participants' Agreements were developed by the Australian Institute for Commercialisation for use by successful CRCs in that round. (These templates will also be used in the 2006 selection round). After considerable negotiation among the participants, one CRC adopted Option 2, which enabled the CRC to secure a tax exempt status. However, the external legal and tax costs incurred to negotiate with the participants to prepare and agree on the structure of the CRC and then enter into the Participants' Agreement were $55,000. A single uniform structure agreement would eliminate negotiation between the participants and the anticipated legal and tax costs for the Participants' Agreement would be in the order of $10,000.

The Ideal Model

Option 2 of the Australian Institute for Commercialisation template agreements is the only option that delivers the above company structure. Other models are more complex and inflexible, and are designed to provide cash returns to participants, significantly reducing the likelihood of reinvestment and thus sustainability of CRCs.

DEST is applauded for insisting on incorporation. There is also scope to enhance the operation of CRCs around issues of legal and beneficial IP ownership and the ability to reinvest commercialisation income into further research. To ensure the CRC Programme Objective can be achieved, especially the long-term sustainability of CRCs and their contribution to Australia's economic and social development, it is recommended that DEST should also specify that:

- the CRC company has legal and beneficial ownership of their IP, and
- should reinvest commercialisation income into further research.

These conditions will lay the ground work for a successful application for tax exemption and also remove capital gains tax impediments to some commercialisation pathways, such as spin-off companies. If a particular CRC wishes to adopt an alternative company model then they should justify this decision to DEST.

A further major benefit of this approach to the CRC company structure as recommended above is that the time and cost of establishing a CRC will be reduced dramatically, as demonstrated above.

Tax Reform

The process of establishing a CRC would be shortened if the rules applying to the R&D tax concession were made uniform for all models of CRC structures. This is in support of the CRC Association Productivity Commission Submission (pg 19), which states that:

The current taxation legislation and rules are driving complex governance arrangements for incorporated CRCs. Tax rules are driving structures which are not necessarily the most efficient or effective. It is appropriate that CRCs… have high governance standards, and taxation issues should not be a policy driver.

Quantum of Funding

The group of CRCs preparing this submission agree that it is preferable to fully fund fewer CRCs than to have higher numbers of CRCs which are inadequately funded. These CRCs therefore support Recommendation 1 of the CRC Association's Submission to the Productivity Commission, that:

The CRC Programme should be funded at the level required for each bi-annual funding round to award at least fifteen to twenty grants per round with each grant carrying an average value of at least $40 million in current dollar terms. This would provide a strong incentive for universities, CSIRO and industry to continue to engage in the CRC Programme and would, by directing additional resources into highly outcomes focussed research, help deliver a better return for Australia on such resource.

Case Studies

Impact of a sub-optimal company structure

The Beef CRC graduated in its third term from an unincorporated joint venture into an incorporated company limited by guarantee in the 2004 selection round. The Participants (namely the 'owners' of the CRC) were not prepared to consider use of 'Option 2', whereby the CRC company legally and beneficially owns all Centre IP. Instead the Beef CRC's Participants required that:

- the CRC company would legally own Centre IP in trust for the Participants
- that funding revenue from the commercialisation of Centre IP be returned to their own organisations.

Hence, the Beef CRC opted for a 'hybrid' model, bringing difficulties that would best be avoided if possible. They include:

- significantly increased time and legal costs to negotiate Centre Agreements (including Supporting Participants' agreements)
- very complex revenue sharing arrangements on a project-by-project basis with payments to the Participants on an annual basis depending on their equity in the IP (if they are a Participant) and on their equity in the project (if they are a Supporting Participant). As a result of all commercialisation revenue being returned to the Participants, the CRC itself is unable to financially build on its own success
- the lack of tax exemption. As a result of the hybrid structure, the Beef CRC is a tax-paying entity, which means increased costs to manage income and expenditure to minimise tax paid. Even with expert management, the transactions are not cost-neutral, as the Beef CRC must pay tax in Year 1 on all capital purchases and then reclaim the tax over subsequent years as it claims depreciation on the capital items
- allowing organisations to 'cherry-pick' their co-investments. For example, in the Beef CRC, one organisation is only participating in those projects where it is able to maximise return on IP commercialisation
- administrative delays. Because 'cherry-picking' is possible, it has taken more than 12 months (and high legal costs) to finalise the Supporting Participants' agreement with that one organisation, to ensure it does not receive all the commercial benefits and take none of the risks that the Participants have accepted.

Conversely, choosing Option 2 would have ensured:

- proceeds from commercialisation of IP were retained by the company for use in ongoing R&D
- prevention of taxation inefficiencies
- 'cherry-picking' would not be possible as the benefits would be returned to the CRC company
- prevention of extended and complex legal negotiations would have been avoided.

Issues in Summary

- The company structure of a CRC has an enormous impact on its efficiency.
- Choosing a less than optimal structure can increase the costs of administration and transactions.
- Having the right structure substantially improves overall CRC efficiency.

Recommendations

Recommendation 7

DEST should be prescriptive by insisting the optimal model (Option 2) is used by newly formed CRCs. DEST should specify that the CRC company has legal and beneficial ownership of their IP.

Recommendation 8

Taxation rules should be made consistent. CRCs should be on the same footing as other government-funded research organisations, namely tax exempt entities.

Recommendation 9

CRC grants should be for at least $40 million to ensure constructive and operationally efficient levels of funding, particularly in an environment where the costs of research are rising.

3.2 The re-bid process

CRC re-bids are very resource intensive, costly and time consuming. The process can be very demanding and distracting for existing CRCs who have a considerable amount of simultaneous utilisation and commercialisation activity underway. This situation works against effectively managing, maximizing, and reacting to opportunities arising in the marketplace and reduces a CRC's productivity.

CRCs are caught between the expectation that they will solve industry issues and deliver economic impacts within a short time frame, and the requirement under the CRC Programme Objective that they become "sustained, user-driven, cooperative public-private research centres". To some extent, the two concepts are incompatible, particularly since it is the discipline of a limited lifespan which forces CRCs to concentrate on getting the results of applied research and development to industry.

The current application renewal process

The senior management team of a CRC usually begins work on a new bid up to two years before an application is lodged, with an increasing proportion of their time committed to the process as deadlines approach.

The formal application process takes about nine months, with three significant hurdles before success or otherwise is announced. It can then take up to a year or more to develop the agreements and gain sign off by the Participants.

Outside of the rebid process, CRCs are already involved in one of the most scrutinised funding programs. They are thoroughly reviewed on an ongoing basis through quarterly financial returns, detailed annual reports and management data questionnaires and first, third and fifth year reviews. This should be taken into account to reduce the rebid process.

Impact of company structure on re-bid efficiency

Experience has shown that the research institution participants of a CRC have a major impact on the latter part of this process. This stage of the CRC lifecycle could be dramatically streamlined if an optimal structure was specified at the time of establishment, as outlined in the previous section. This would prevent CRCs setting up structures which prove to be complex and inflexible at the time of the re-bid. Most importantly, it would defuse tension between the CRC participants over ownership of the IP, as the optimal structure determines that the IP belongs to the CRC.

While CRCs have only a seven year life, the average time to achieve economic impacts from research and development activities is 9 years. Typically, if a CRC possessing potentially marketable IP does not succeed in establishing a 'new from existing CRC', the IP must be assigned to another party before the CRC is wound up. Given the time frames involved in commercialisation of IP, this usually means the IP is either never commercialised or its commercialisation is extensively delayed due to the transfer to another party.

In line with earlier discussion, the establishment of a mandatory business model for CRCs would also lessen the impact of re-establishing CRCs following the re-bid process and decrease significantly the legal and administrative costs involved.

Impact of re-bids

The need to simplify the re-bid process should be balanced with the desire of CRCs to remain flexible and adaptable. The renewal process is one of the keys to the CRCs' success, as they do not become entrenched in their activities, but remain responsive to specific industry needs.

However, the impact of re-bids on a CRC can be negative in many regards. While sound management can mitigate the impact, there are frequent reports of an adverse effect on CRC personnel, including management staff involved in preparing the re-bid and research staff confronting the uncertainty of future employment. This is not an optimal situation and also leads to refunded CRCs taking some time before returning to full operating capacity. Some CRC Participants are forced to implement a back-up strategy to avoid the ramifications should the CRC not be renewed. This can have the effect of reducing collaboration and diverting resources away from a new CRC.

To address this problem, Vision CRC has taken steps for its Core Partners to commit to ongoing educational support of PhD students working with the CRC to ensure student intake is not truncated due to the CRC life cycle, and to prevent students from being disadvantaged by association with the CRC in its latter years.

The limited timeframe in the lifecycle of CRCs causes concern for some CRCs over losing quality research staff during administrative transitions, and the inability to commit to longer-term projects. Cut-offs imposed by the funding cycle may cause projects running towards the end of the funding period to be abandoned. The timing and format of the process is very disruptive. Coming in the fifth year of operation when the focus should be on delivery of CRC outcomes, the distraction of preparing a new application can be quite disruptive and can potentially cause a loss of continuity in the innovation process.

The requirement that the application for the new CRC needs to be significantly different from the existing one means that effort is diverted from delivery of existing CRC outcomes at a crucial stage. If a renewal application is successful, it effectively truncates the funding for existing CRC activities, as year 7 of the existing CRC is combined with year 1 of the new CRC. Breaking off the contract one year early also damages the relationship with parties that do not intend to continue in the new CRC.

Post-CRC life

Anecdotally, the majority of CRCs do not survive in an alternate form once their final CRC term is wound up. Many CRCs generate spin off companies in the course of their life, but this does not equate to the longer term utilisation or preservation of all the R&D conducted by the CRC itself. There are occasional examples, such as the CRC for Tissue Growth Repair, which became a stand-alone company after its life as a CRC. Similarly, the CRC for Legumes and Mediterranean Agriculture was absorbed into the University of Western Australia as a research centre.

In regard to the impacts of CRC closures, beyond the loss of employment, this can include the loss of ongoing and new research opportunities, fruitful collaborations, core expertise (both research-related and in project and IP management), and loss of the well-supported postgraduate student places provided by CRCs.

There is merit in undertaking a longer term mapping exercise to complete the analysis of CRC contributions to the development of Australian industry.

Alternative approaches

Those CRCs that are in their third term, achieving the CRC Programme Objectives and working in an area of ongoing national priority, should be assessed for continued funding on a different basis. They should not be subjected to the threat of a sudden cessation of funding, as this instability affects the industry and other end-user participants just as much as the research providers. At the same time, they should not be funded perpetually, as this would reduce the very responsiveness that makes them so effective in addressing industry's needs.

These requirements could be balanced by setting certain criteria that a CRC needs to achieve on an on-going basis to continue to receive funding. Such CRCs could be known as 'CRC Institutes'.

CRC Institutes

A new funding mechanism could allow CRCs to readily grow or shrink according to the level of end-user support. The Commonwealth's contribution to ongoing CRCs could be funded according to a formula such as:

the value of the base funding for sustainable operation of the CRC plus the multiplication of industry and end-user cash contributions, with different values assigned to different categories of engagement (eg: research, SME technology transfer activities and post-graduate education.)

CRC Institutes would commit to a certain level of industry (end-user) cash contributions but the actual amount of funding received would depend on the level of end-user funds collected annually, so that the grant can increase and decrease in response to changes in end-user support over time. If the end-user contributions drop below a certain level then the CRC may be considered to be unviable and a wind-up phase implemented.

It is believed that this flexible funding arrangement would encourage CRC Institutes to grow and engage more broadly with end users. These CRC Institutes would still need to report annually against appropriate key performance indicators (KPIs) and should undergo a major review every three years. This would ensure the hallmarks of CRCs - scientific excellence, innovation and collaboration - are maintained in the CRC Institute's activities. Further, the CRC Institute model, which allows for longer-term planning, would support the important educational capacity of CRCs, in providing ongoing industry training programs, post-doctoral research training and industry-ready graduates.

It is recommended that the concept of CRC Institutes be considered as a mechanism for ensuring that mature, high performing CRCs continually increase the economic value of their outcomes for the benefit of the nation.

Issues in Summary

- The review process is considered constructive, as it keeps CRCs fresh and accountable to KPIs.
- The current renewal application process is costly as it consumes several years in the re-bid and re-establishment phases.
- The company structure of CRCs has impacts on the efficiency of the renewal or wind-up process.

Recommendations

Recommendation 10

Enforce optimal company structure at the commencement of a CRC.

Recommendation 11

Consider measures to reduce the time consumed in the renewal application process.

Recommendation 12

Allow those CRCs that are achieving strongly in their third term to be assessed for continued funding on a different basis, such as through a CRC Institutes model.

3.3 CRC interaction and collaboration with the CSIRO and Universities

CRCs, CSIRO and Australian universities form the core of Australia's R&D, science and innovation community. CRCs have a highly specific relationship with CSIRO and universities: all but one of the CRCs contributing to this submission has CSIRO as either a Core or Supporting Participant. They all have at least two and up to nine universities in this role (for a full breakdown of members for each CRC please refer to Appendix A).

There are numerous examples of best practice and excellence in the outcomes of collaborative projects between CRCs, CSIRO and the universities, as outlined in the case studies below.

However these relationships, while effective as generators of outstanding scientific development, are at times fraught with tension largely attributable to the divergent KPIs under which the different parties operate. These differences ensure complementarity between the three bodies, however it can also have the unintended effect of creating friction that reduces the ability of the CRCs to effectively achieve their objectives.

CRCs generally do not have commercialisation revenue as a critical KPI, putting them at odds with their research partners, for whom this is often a high priority. To a large degree, this issue would be ameliorated by the introduction of the ideal compulsory CRC structure that prescribes the treatment of IP and commercialisation revenue, negating these as potential sources of friction between the CRC participants.

In approaching collaboration, some CRCs find it more effective to increase the cash contributions of partners, rather than relying on in-kind contributions of staff time from the CRC's partners. The cash flow enables the CRC to contract the specific skill sets they need, which may be more relevant than those available from the CRC partners. This strategy has worked successfully for the Mining CRC, which has reported efficiency improvements due to its highly targeted recruitment of specialist researchers.

CSIRO

CSIRO operational staff typically demonstrate excellent research and reporting skills and reliable delivery. They are well trained in IP issues, and the rigorous policies and procedures under which they operate make them a valued research partner. Some CRCs have reported difficulties in dealing with the corporate level of CSIRO. These issues could be effectively addressed by CRC Programme endorsement of the Option 2 business model.

Universities

Universities play a key role in CRCs through the commitment of key researchers and supervision of post-graduate research students. Some of the most successful collaboration between CRCs and universities has occurred where university staff performance measures align with CRC involvement. At the University of Tasmania, academic performance management measures now include successful involvement in CRCs. The CEO of the CRC is asked to provide input into the performance management process. This initiative has been enormously effective in ensuring productive and valuable collaboration.

A major issue for some CRCs in partnering with universities is the limited ability of academics to make a significant amount of in kind contribution to research projects. The funding model for universities means that some universities contribute far lower in-kind inputs than other research institutions, and this inequity causes considerable friction amongst participants.

Operational level collaboration by University staff and students is sometimes inhibited by their numerous other university commitments. Post-doctoral researchers play a very

important role in CRCs, but often their contributions are not adequately recognised by universities and they can feel cut off from an academic career due to their CRC involvement.

Case Studies

CSIRO and University Involvement at Operational Level

Meat Standards Australia (MSA)

MSA is Australia's unique beef grading scheme that guarantees the eating quality of Australian beef. The economic values of this are being included in the second economic impact study referred to in the CRCA submission (pg 3), as an example of Category 1 activity (i.e. delivered value, verified by industry). CSIRO, UNE and Murdoch University scientists were key in delivering the science that underpins MSA and three scientists from these institutions continue to sit on the MSA Pathways team, which was recognised in 2000 with the International Meat Science Secretariat Prize awarded in Brazil.

Excellence in Innovation Award

Four Beef CRC technologies that contribute to guaranteed beef eating quality were collectively awarded an 'excellence in innovation' award. CSIRO and University staff were involved in the development of all technologies, including the CRC's progeny test schemes, flight time and DNA tests, all of which involved both CSIRO and university scientists.

The role of the CRC in the Forestry Research arena

The CRC has played a highly significant role in research and skills development in the forestry sector, as well as in the 'public good' areas of research. It has also enjoyed a high degree of industry support. The partnering universities have benefited through the flow of students, research content and interaction with the industry and CSIRO. Experience indicates that CSIRO researchers in the CRC have benefited in terms of closer linkages to other researchers, industry and access to well trained graduate students.

Issues in Summary

- The efficient operation of Australia's science and innovation system is heavily dependent on effective collaboration between CRCs, universities and CSIRO.
- Divergent KPIs create friction between parties, but this could be ameliorated by adjusting KPIs and enforcing the use of the optimal CRC structure.

Recommendations

Recommendation 13

Enforce the ideal CRC company model as a mechanism to streamline relations between CRCs and other public research organisations.

Recommendation 14

Improve the alignment of KPIs for universities and CSIRO with CRC Programme Objectives.

3.4 Objectives and measurement

In considering the issue of objectives and measurement in relation to CRC activity, it is helpful to revisit the overarching Objective of the CRC Programme, namely:

*to enhance Australia's industrial, commercial and economic growth through the development of **sustained**, **user-driven**, cooperative public-private research centres that achieve **high levels of outcomes in adoption and commercialisation**.*

It is important to recognise that under the CRC Programme Objective, economic impact on industry is the key measure for CRCs, not commercial revenue earned. This encompasses the wide range of benefit to industry which CRCs produce, and extends to public-good research, another important aspect of the work of CRCs. This work typically addresses macro-level issues, finding scientific bases for how industry is operating. The experience of the CRCs is that industry is aware of this and supports this dimension of CRC work.

The study on economic impacts of CRCs initiated by the CRC Association in 2005 showed that on average, nine years is required to produce incontrovertible evidence of economic benefits resulting from CRC research. CRCs are required to document these benefits well before this time and there are clearly a number of ways in which economic impacts can be predicted and measured. Uncertainty in the methodology and the need for most CRCs to develop it on a case-by-case basis means that it is a very expensive and inexact science.

It is widely agreed that it is difficult to apply standard performance measures across the CRCs, as their range of activities and target markets vary enormously. Previous studies acknowledge that many beneficial impacts of CRCs cannot be quantified by economic impact methodologies.

The consistent theme across the CRCs contributing to this submission is that they are strongly impact-oriented and have a culture of applying targets that relate specifically to industry outcomes. In some cases, the CRC's objectives and benefits may be social rather than economic. The case study below includes the Vision CRCs, whose impacts frequently have a strong social element, and the Beef CRC, whose target market is 170,000 SMEs around the nation. These case studies demonstrate innovative ways to meet the challenge of measuring impact across the range of objectives of CRCs.

Relationship to other R&D bodies

In attempting to compare relative performance of research organisations, it is critical that the broad impact on industry of CRCs be taken into account. While other research bodies tend to be 'output' oriented (eg: patents registered, papers published), CRCs are 'outcome' oriented (eg: successful adoption of CRC generated IP by a significant proportion of a particular industry). This is often directly related to the driving charters and objectives of each organisation. As already described, this divergence in KPIs can create friction between CRCs and other research bodies. An analysis of the core KPIs of each major publicly funded research organisation or program would improve alignment and generate more productive relationships.

Based on the 2005 study commissioned by the CRC Association, for every $1 spent by the Commonwealth Government on the CRC Programme, GDP is cumulatively $0.60 higher than it would have been had that $1 been allocated to general Government expenditure. Such indicators are strong starting points for determining the comparative value of Government spend on research institutions.

Evaluation of CRCs and Funding Decisions

Given the success of CRCs in building industry through research relative to other Government funded organisations, the Government needs to reconsider the weight of funding given to CRCs. The CRCs contributing to this submission endorse Recommendation 1 of the CRC Association's submission to the Productivity Commission:

The CRC Programme should be funded at the level required for each bi-annual funding round to award at least fifteen to twenty grants per round with each grant carrying an average value of at least $40 million in current dollar terms. This would provide a strong incentive for universities, CSIRO and industry to continue to engage in the CRC Programme and would, by directing additional resources into highly outcomes focussed research, help deliver a better return for Australia on such resource.

There is potential for the impact of research undertaken by CRCs and other organisations to be independently reviewed via nationally coordinated surveys. There are already a number of national surveys conducted by the Australian Bureau of Statistics and ABARE. It may be possible to include questions in these national surveys to evaluate impact of research at a national level.

Assessment of economic impact is also critical for effective functioning of the Research Quality Framework (RQF). The Group endorse Recommendation 3 of the CRCA submission:

To ensure that the RQF encourages research of the highest benefit to Australia, the CRC Association recommends that within the RQF the end impact of research is given a weighting of 50 per cent within the overall RQF funding outcomes and that the impact of research is reported separately from the academic quality of research within the RQF.

The difficulty of objective measurement of impact means that most indicators will tend to concentrate on easier to measure parameters such as number of publications. These may not have the desired result in terms of capturing economic impact on industry.

The case studies below demonstrate the innovative and highly sector specific performance measures used by CRCs.

Case Studies

Performance Indicators

Vision CRC

CRC Programme Objective 1: To enhance the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development

Centre Objectives

1.1 To conduct world class research and development which will deliver better eyecare and maximise commercial opportunities for the Centre and Australia. Measured through refereed journals, books, chapters or abstracts published; impact factor of refereed publications; and awards.

1.2 To develop breakthrough products for the rapidly growing myopia and presbyopia markets. Measured through development of next generation continuous wear contact lenses with improved comfort, affordability, bacteria prevention and safe and effective use for children; corneal onlay for permanent vision correction; anti-myopia products; multi-focal soft contact lenses; and accommodative gel and correction lens system to restore vision for the ageing eye.

1.3 To communicate Centre-developed information to benefit the scientific, industry and broader communities, and to enhance Centre and Australian standing and opportunity.

Measured through presentations at research conferences; conferences arranged by Vision CRC; educational papers and courses presented; and media items.

CRC Programme Objective 2: To enhance the transfer of research outputs into commercial or other outcomes of economic, environmental or social benefit to Australia

Centre Objectives

2.1 To develop and commercialise Centre IP for the maximum benefit of the Centre and Australia. Measured through patents applied for, granted and maintained; invention disclosures filed; and income from royalties and educational programs.

2.2 To work with Australian and international industry in the development of products and systems to meet industry and community needs. Measured through cash and in-kind industry contributions.

CRC Programme Objective 3: To enhance the value to Australia of graduate researchers

Centre Objectives

3.1 To produce high quality graduates to build future research and industry in Australia and internationally. Measured through student enrolments and completions; post-graduate publications; and graduate employment.

3.2 To develop innovative educational programs which will meet the needs of the Australian and international profession and industry for high quality continuing education to support business growth. Measured through professional education course completions.

3.3 To support the career development and enhance the expertise of Centre staff. Measured through staff training courses delivered.

CRC Programme Objective 4: To enhance collaboration among researchers, between researchers and industry or other users, & to improve efficiency in the use of intellectual and other research resources

Centre Objectives

4.1 To work with the best in the world to achieve Centre objectives. Measured through number and quality of organisations interacting with Vision CRCs.

4.2 To develop effective national and international collaborations that will maximise synergy, resources and opportunity. Measured through visitors to CRC; visits to industry; publications with authors from more than one organisation; staff participating in post-graduate education programs; leverage on Commonwealth funds; and percentage of research projects involving more than one participant.

These measures have been extremely useful to the Centre to be able to evaluate activities at a glance against Programme and Centre objectives. These objectives were designed to capture the range of Vision CRC activities, including research, economic, academic, social and public health impacts.

Beef CRC

The Beef CRC is focussing on four high priority beef issues with the following planned outcomes:

Program 1: High Quality Beef for Global Consumers:

- From 2012, 10% of Australian beef sires will be evaluated for multiple DNA tests that account for 50% of the genetic differences in carcase yield, marbling and beef tenderness, increasing annual gross revenues in the Australian beef industry by $43 million for improved beef quality and a further $15.5 million for increased retail beef yield.
- By 2012, the compliance rate for cattle achieving market specifications will be increased by 20% with concomitant improvements in profitability due to improved operational, environmental and production efficiencies and increased throughput across the supply chain.
- By 2012, palatability prediction models, customised for international markets, will be developed and used by at least two of our key trading partners.

Program 2: Feed Efficiency, Maternal Productivity and Responsible Resource Use:

- From 2012, feed costs for the national beef herd will be reduced by $15.5 million per annum without impacting on cattle weight gain, through genetic improvement of feed efficiency in seedstock cattle.
- From 2012, breeding herd efficiency (kg calf / MJ energy per cow and calf unit) will be improved on average by 0.5% per annum in at least 50% of specialist beef enterprises in temperate Australia.
- By 2012, commercial products and management strategies developed by the CRC will be used by 50% of feedlots and 20% of grazing enterprises to decrease methane emissions from beef cattle by 20% and increase dietary energy captured for production by 5–10%.

Program 3: Adaptation and Cattle Welfare:

- From 2012, the combined effects of reduced parasite control costs and improved productivity from use of optimally adapted cattle and improvements in animal welfare will increase the gross annual revenue of the Australian beef industry by $43 million.

Program 4: Female Reproductive Performance:

- Every year from 2012 an improvement of $46.5 million will be achieved in the gross annual revenue of the Australian beef industry due to improved reproductive performance of the beef breeding herd with no impact on breeder herd mortalities due to younger age of joining and with cows rearing their calves to normal weaning age of 6-9 months.

These outcomes are being measured on an annual basis using a range of KPIs including a beef industry profitability framework that records the number of technologies adopted by industry end-users and the economic impact of those technologies in beef businesses.

Issues in Summary

- CRCs are strongly oriented towards outcomes (rather than outputs) and industry impacts, which can be difficult to measure.
- Direct comparisons on the same performance criteria between CRCs and other research bodies are unhelpful and incomplete.
- The interaction between publicly funded research organisations would be enhanced by improved alignment of KPIs.
- The difficulty in establishing standard performance measures applicable across all CRCs means that value is not always captured.

Recommendations

Recommendation 15

Improve the general understanding and acceptance of the highly specific measures appropriate to CRCs and ensure that funding decisions are based on these measures.

3.5 Commercialisation and Utilisation

CRCs are very agile in pursuing a variety of commercialisation or utilisation models, as appropriate to the industry sector. Being intimately linked to the marketplace, CRCs have the benefit of being able to identify issues industry will benefit from and target candidates for commercialisation. With their unique structure and direct access to a range of organisations, CRCs also have the ability to take flexible approaches to commercialising and disseminating technologies to ensure industry utilisation. This is demonstrated by the case studies below.

CRC objectives are primarily to return benefit to industry, rather than benefits to the CRC itself. In determining an appropriate rate to which CRC research should aim, 2% commercialisation returns is a good target figure. This compares favourably with international benchmarks of 2.9% (MIT) and 3.9% (Canadian universities)[1].

Commercialisation costs $20 for every $1 spent on R&D. No CRC has the funding to invest totally in commercialisation. This requires additional funds, which CRCs must source, with varied success and sometimes compromised delivery of technology direct to industry. There is also a need for separate funds to drive technology uptake by SMEs (eg patents, technology service delivery companies), as there may be insufficient resources within the CRC to reach all SMEs in the target market. CRCs should have access to any pool of funds created for commercialisation purposes. CRCs are currently unable to access Government schemes which would enable commercialisation, such as the COMET and Commercial Ready programs. In offering support for commercialisation, Government should carefully consider criteria which limit the scope of applicants who have access to these pools of funds.

Models for Commercialisation/Utilisation

CRCs' emphasis on industry over self-interest has resulted in more effective and diverse approaches to commercialisation than those used by other public research organisations. On occasions, CRCs have forgone royalties and patents to ensure that the CRC is commercially viable and can deliver to the industry. Often the result is greater stimulation of technology spin-offs to other sectors and social benefits, as demonstrated below. Examples of different paths CRCs have taken to ensure utilisation and uptake of technology by industry include:

- The experience of Beef CRC in delivering its science through the Meat Standards Australia program clearly demonstrates the direct application of technology in industry rather than taking an IP or trademark position, to ensure industry adoption ($244 million delivered value to June 2006 [CRCA Economic Impact Study 2]) rather than returns to the organisation. The key partners, Meat and Livestock Australia and the Beef CRC, made a conscious decision that the science was best placed in the public domain to achieve greatest economic impact.
- In its work with DNA markers, the Beef CRC took an IP protection approach to give delivery partner, Genetic Solutions, the security they required through exclusive licenses to further co-invest to develop and commercialise the diagnostic DNA tests associated with beef eating quality.
- One of the important utilisation functions that a CRC can provide is to make available information to the industry in a form that is easily accessed. The Sheep and Beef CRCs have pursued this through working together to establish an internet based livestock library.

[1] 2002 Adjusted Gross Licence Income as Percentage of Research. Department of Education, Science and Training, 2004, National survey of research commercialisation years 2001 and 2002

- Vision CRC has taken a number of paths to commercialisation and technology transfer, including licensing to international companies, spinning off companies, and selling training packages or eyecare models.

Impediments

One of the major issues in R&D undertaken by CRCs is user-application of IP. These IP issues take many forms. Where the ideal business model is lacking (see section 3.1), CRCs often find it difficult to negotiate ownership of IP rights with other CRC participants. This causes problems in the delivery of technology to industry, where delivery is sometimes best achieved through CRCs making exclusive licences available to third party delivery service providers. Leaving aside the question of the availability of commercialisation funding for CRCs, without ownership of these IP rights, licensing by a third party is not possible unless negotiated with the participants who own the IP.

The Sheep and Beef CRC's have worked together to establish an internet based livestock library so that information is available to industry in a form that is easily accessed. One of the major issues in the establishment and running of this resource is copyright. Copyright has also been a major issue for the Sheep CRC as it prepares lecture material for undergraduates that also has significant value for many industry practitioners. Restrictions of the Part 5B Copyright Act makes it impossible to use material for undergraduate teaching for broader industry access without the considerable cost of seeking copyright clearance.

Government regulations also create impediments to commercialisation and the utilisation of CRC-developed technologies. One example is in the area of Genetically Modified Organisms (GMO), where the current regulatory review pathway causes impediments to efficient research in immunobiological products. This issue is relevant to most CRCs dealing with plant and animal health and is explored in further detail below.

Taxation issues also affect the ability for CRCs to commercialise through spin-off companies. The creation of such companies results in the application of capital gains tax, which has the effect of undermining their viability.

Case Studies

Vision CRC – commercialisation through engagement with industry

Vision CRC is developing programs that contribute to technology transfer and the expansion of the eyecare business, including:

- Practitioner and educator training courses
- Public awareness/advocacy, where the Vision CRC is contributing to the Vision Initiative to increase Australian community awareness of the importance of vision.
- Industry training, where Vision CRC is developing training modules and materials for Australian and international industry staff as an important way to enhance the eyecare business and package Centre expertise for excellent return.
- Delivering education to increase the number of eyecare practitioners in developing countries and help to develop the eyecare business in these regions
- Business Growth and Education programs specifically targeted at improving the performance of SME optometrists, enabling them in turn to more effectively take up innovative new technologies from the CRC.

Vision CRC – commercialisation through collaboration

A highly successful collaboration between the CRC and multinational CIBA Vision has resulted in development of market-leading products. The first of these is a breakthrough highly oxygen permeable soft contact lens designed to be worn continuously for a month,

while allowing the oxygen permeability needed for healthy long-term wear. Launched internationally in 1999, the 'Focus Night and Day™' lens has rapidly taken a major role in the vision correction market and was the fastest contact lens product to reach $1 million in sales.

The lens is expected to earn Australia a multi-million dollar income from the 3% royalty stream, which is used by the CRC to fund future research, to create new jobs and post-graduate student positions.

The collaborative project also created over 40 novel polymers. These may have substantial other uses including drug delivery and wound healing, and a spin–off company to exploit the non-ophthalmic applications of the polymers has been established by CIBA Vision/Novartis, the CRC and the Institute for Eye Research.

The long-term multidisciplinary CRC/CIBA collaboration has now resulted in another highly oxygen permeable lens - O2OPTIX. This is a more affordable daily wear lens and was launched in the US in September 2004 and in Australia in February 2005. The uptake by contact lens wearers has been high. Sales of O2OPTIX and NIGHT & DAY® contact lenses, developed by the same team, generated US$10m in royalties for Vision CRC in 2004/05. That figure is expected to rise significantly over the life of the patents, which extend to 2014.

This demonstrates the social and spin-off benefits derived from the creative approach to commercialisation.

Precision sheep production

The Sheep CRC program of precision sheep production relies on the involvement and commitment of a large number of light industrial manufacturing industries and software companies in Australian and New Zealand. The CRC's ability to integrate and coordinate R & D as well as commercial activities across a broad spectrum of these organizations has made this ambitious task of implementing precision sheep production one that is achievable.

The range of different industry partners includes the radio frequency identification technology (Allflex), electronic weighing systems (Tru-Test and Ruddweigh), sheep handling equipment (Prattley) software and data managements systems (Allstock and Practical Systems), integrators (Sunshine Technologies) and communication technology (Telstra). The CRC participants have developed software and operating systems that integrate and complement the available technologies. Working with this range of organizations in this way the CRC has been able to commercialise and deliver to industry robust systems that transform the management of sheep.

o.d.t. Engineering (casting company) - SME

o.d.t. Engineering is a small family owned enterprise located in Melbourne that manufactures large-scale equipment for the casting operations of Comalco, Alcoa and Hydro Aluminium as well as exports to international cast houses.

These machines are used for ingot casting and direct chill casting of aluminium to form products to be used by cast component and wrought alloy product manufacturers. o.d.t. Engineering competes with European, North American and low cost Asian machine manufacturers in this market and need a technological edge to maintain competitive advantage.

o.d.t Engineering joined the CAST CRC in 2001 to develop new higher productivity casting technologies following an initial contract research project. This research area was also of interest to one of CAST's existing partners and o.d.t. customer, Comalco Aluminium. CAST took a first principles approach to develop o.d.t.'s required technologies, combining science with sophisticated computer simulation techniques to understand the thermal, stress and fluid flow aspects of ingot and direct chill casting.

The result is three patent-protected CAST-developed technologies and related know how that were licensed to o.d.t. Engineering during 2005-06: CASTfill and CASTmould (ingot casting technologies), and AirCAST (direct chill casting technology). These technologies are now available in the marketplace with sales of each product already achieved.

CAST continues to provide technical support to o.d.t to ensure that CASTfill, CASTmould and AirCAST are successfully installed and commissioned in the customer's industrial cast houses. To quote Kurt Oswald, managing director of o.d.t. Engineering, 'With CAST, o.d.t. has gone from an importer to an exporter of leading edge technology'.

Once again, a flexible approach to commercialising technology created an optimal outcome for an SME and considerable spin-off benefits to the industry.

Impediments to commercialisation of GMO products as opposed to non-GMO products in Australia

CRCs wishing to invest in immunobiological products in Australia almost invariably need to make use of technology containing a Genetically Modified Organism (GMO). One impediment to the successful commercialisation of these immunobiological products is the regulatory pathway they must traverse before the first commercial sale.

The current regulatory review pathway for the commercialisation of a GMO involves the following:

- An application for a Dealing involving Intentional Release (DIR) made to the Office of the Gene Technology Regulator (OGTR). The application and its review take approximately 170 working days (6 months)
- After receiving approval, the research organisation must conduct a study and provide the report demonstrating safety to the environment and humans (as a minimum this takes approximately 6 months).
- An application for a field trial must then be made to the Australian Pesticides and Veterinary Medicines Authority (APVMA) under Guideline 23. The APVMA take a minimum of 6 months to review the application which is then followed by the field trial. This may take 12 months to conduct and includes a report to the APVMA.
- The next step is a review of the registration dossier by the APVMA under Guideline 47. This takes a minimum of 12 months.
- After this, an application must be made to the OGTR for a DIR commercial licence. This application is processed by the OGTR over a statutory period of 255 working days.
- Once these steps have been completed, the first commercial sale may occur and in aggregate, the processes take at least 4-5 years.

The OGTR and the APVMA claim that these processes may take place in parallel, however, the practical reality is that these processes must take place consecutively. The reason that these processes occur consecutively is the different objectives and requirements of the two organisations.

The OGTR's objective is to ensure that the intentional release is confined to permit the evaluation of the environmental threat by assessing transmission and persistence of the organism in the environment. In the first instance, the OGTR requires that the release be confined so as to limit environmental exposure and risk during the evaluation process.

However, the APVMA requires an assessment of the product safety and efficacy. This requires that multiple farms be involved in multiple geographic regions and in multiple animal genotypes, with sufficient numbers of farms and animals involved to ensure that the results are statistically robust. Therefore, the practical effect is that the two regulatory bodies' review processes must operate in a consecutive nature, not in parallel as intended.

Any delay in making the first commercial sale of any product significantly reduces the net present value (NPV) and thus the confidence of an organisation to invest in the research project. Australia is perceived to have the highest regulatory standards for GMOs internationally, thus potential investors in projects involving commercialisation of immunobiologicals containing GMOs are likely to consider funding part, if not all, of these projects offshore.

CRCs remain committed to ensuring that the objectives of both the OGTR and the APVMA are met. The issue here is the delay in achieving approval created by the interaction between the regulatory processes.

There are two ways in which the delay could be reduced:

- Firstly, if the OGTR included a dedicated commercial division that worked closely with researchers and commercial partners from early on in the developmental process, this would enable the identification of higher risk issues so that they can be addressed during the developmental period. Biological products with commercial intent are usually known at the commencement of the project, and these could be dealt with by a commercial division to streamline the review process and ensure a closer relationship between the OGTR regulatory officers and the organisation developing the product.
- Secondly, because of the volume of material which is already submitted to the APVMA during the field trial review, the information provided in the registration dossier review could be truncated.

Issues in Summary

- CRCs have the ability to take a flexible approach to commercialisation and utilisation based on the specific requirements and aspects of the industry in question in order to maximise the benefits derived, rather than prioritising a revenue stream.
- In certain cases (eg: copyright and dealing with GMOs), government regulation impedes the commercialisation process.

Recommendations

Recommendation 16

Support CRCs' flexible but effective approach to commercialisation that guarantees benefits to industry and the Australian economy as the primary aim.

Recommendation 17

Identify and address regulatory and tax impediments to commercialisation, especially IP/copyright considerations, research ethics schemes and the effect of capital gains tax on commercialisation opportunities.

Recommendation 18

Government should reconsider criteria which limit CRCs' ability to apply for commercialisation funding, such as COMET and Commercial Ready programs.

4 Conclusion and Summary Recommendations

Australia's CRCs deliver benefits back to Australia's performance in the areas of economic and productivity outcomes that are disproportionately high in regard to the funding commitment to them.

They are also a model based entirely on industry needs, thereby providing the basis for:

- a better understanding within industry of the benefits of innovation
- increased expenditure by industry on innovation and research and development
- a better appreciation of industry's current and future innovation requirements within the R&D sector.

There are also a range of outcomes from CRC operation that contribute to economic impact through:

- the role that CRCs play in educating and training highly skilled R&D practitioners who then move into roles in industry
- providing a link to international research excellence and activity for Australian industry
- the involvement of a large number of SME organisations who would otherwise have little access to the R&D sector
- generating a range of commercialisation models that assist industry in realising the benefits of the R&D process.

The interest in the replication of the CRC model in a number of other countries including South Africa, Austria, Canada and Chile gives international credence to the operation of the model.

The implementation of the recommendations in this report would see even greater benefit delivered for the public investment into the CRC model. Addressing these issues would result in the achievement of greater efficiencies in operation, and a more comprehensive understanding of the raft of benefits that flow from CRC operation.

The recommendations are summarised as follows.

Recommendation 1

The science and innovation policies of the Australian government should continue to support CRCs and foster further development and expansion of the CRC Programme.

Recommendation 2

R&D tax concession rules should permit unincorporated SMEs to claim in relation to legitimate CRC engagement.

Recommendation 3

Ascribe economic and social value to CRCs' contribution to education, skills and training when assessing both individual CRCs and the achievements of the Programme overall.

Recommendation 4

Consider decreasing the financial barrier to universities that enrol overseas students who work through CRCs to deliver benefits to Australian industry.

Recommendation 5

Value should be ascribed to the international activities of CRCs when assessing both the Programme and individual CRCs. This value should be assessed in terms of benefits returned to Australia.

Recommendation 6

Improve access to international partners by adjusting the funding model for CRCs in relation to DEST's International Science Linkage program.

Recommendation 7

DEST should be prescriptive by insisting the optimal model (Option 2) is used by newly formed CRCs. DEST should specify that the CRC company has legal and beneficial ownership of their IP.

Recommendation 8

Taxation rules should be made consistent. CRCs should be on the same footing as other government-funded research organisations, namely tax exempt entities.

Recommendation 9

CRC grants should be for at least $40 million to ensure constructive and operationally efficient levels of funding, particularly in an environment where the costs of research are rising.

Recommendation 10

Enforce optimal company structure at the commencement of a CRC.

Recommendation 11

Consider measures to reduce the time consumed in the renewal application process.

Recommendation 12

Allow those CRCs that are achieving strongly in their third term to be assessed for continued funding on a different basis, such as through a CRC Institutes model.

Recommendation 13

Enforce the ideal CRC company model as a mechanism to streamline relations between CRCs and other public research organisations.

Recommendation 14

Improve the alignment of KPIs for universities and CSIRO with CRC Programme Objectives.

Recommendation 15

Improve the general understanding and acceptance of the highly specific measures appropriate to CRCs and ensure that funding decisions are based on these measures.

Recommendation 16

Support CRCs' flexible but effective approach to commercialisation that guarantees benefits to industry and the Australian economy as the primary aim.

Recommendation 17

Identify and address regulatory and tax impediments to commercialisation, especially IP/copyright considerations, research ethics schemes and the effect of capital gains tax on commercialisation opportunities.

Recommendation 18

Government should reconsider criteria which limit CRCs' ability to apply for commercialisation funding, such as COMET and Commercial Ready programs.

Appendix A

Parties contributing to the CRCs

Sheep CRC

Core Parties	Supporting Parties
Australian Meat Processor Corporation	Australian Wool Innovation
CSIRO	Australian Wool Education Trust
Western Australia Department of Agriculture and Food	Bett Trust
Queensland Department of Primary Industry and Fisheries	Victorian Department of Primary Industries
NSW Department of Primary Industries	Tasmanian Department of Industries, Water and Environment
The University of New England	Elders
	Fletcher International Exports
	Interactive Wool Group
	Meat and Livestock Australia
	Merino Benchmark
	Murdoch University
	Primary Industries and Resources South Australia
	Sheepmeat Council of Australia
	TAFE NSW
	The Mackinnon Project, University of Melbourne
	The University of Sydney
	WoolProducers

CAST CRC

Core Participants	Supporting Partners
Advanced Magnesium Technologies	Australian Foundry Institute, Qld Division Inc
AMPAL Inc	Australian Nuclear Science and Technology Organisation
Australian Die Casting Association	Australian Government Department of Defence, Defence Science and Technology Organisation
BlueScope Steel	Ferra Engineering Pty Ltd
Central Queensland University	Hatch Australia Pty Ltd
Comalco Aluminium Ltd	Henkel Australia Pty Ltd
CSIRO	Henrob (UK) Pty Ltd
Deakin University	Sutton Tools
Ford Motor Company of Australia Ltd	
Monash University	
Nissan Casting (Australia) Pty Ltd	
o.d.t. Engineering Pty Ltd	
Swinburne University of Technology	
The University of Queensland	

Dairy CRC

Core Partners	Associates
Australian Dairy Farmers Ltd	Australian National University through John Curtin School of Medical Research
CSIRO Livestock Industries	Garvan Institute of Medical Research
Dairy Australia	ProBio Inc
Dairy Farmers Cooperative	University of Melbourne through Department of Zoology
Genetics Australia Cooperative Ltd	
Monash University through Monash Institute of Medical Research	
Tatura Milk Industries Ltd	
The University of Sydney through ReproGen, Centre for Advanced Technologies in Animal Genetics and Reproduction	

Poultry CRC

Core Participants	Supporting Participants
Australian Egg Corporation Ltd	Baiada Poultry Pty Ltd
Bioproperties Pty Ltd	Bartter Enterprises Pty Ltd
Rural Industries Research and Development Corporation	Inghams Enterprises Pty Ltd
The University of New England	Agribiz Engineering (Rural Resources Group Pty Ltd)
The University of Melbourne	Alltech Australia (Alltech Biotechnology Pty Ltd)
	South Australian Research and Development Institute
	CSIRO Livestock Industries
	Victorian Department of Primary Industries
	Queensland Department of Primary Industries and Fisheries
	Monash University
	Queensland University of Technology
	RMIT University
	The University of Adelaide
	The University of Queensland
	The University of New South Wales
	The University of Sydney
	The Norwegian University of Life Sciences (Norway)

Beef CRC

Core Participants	Supporting Participants
Meat and Livestock Australia	Australian Lot Feeders' Association
Meat and Wool New Zealand	Cattle Council of Australia
NSW Department of Primary Industries	CSIRO Livestock Industries
Qld Department of Primary Industries and Fisheries	Genetic Solutions Pty Ltd
South Australian Research and Development Institute	Genus Pty Ltd (USA)
University of Adelaide	Murdoch University
University of New England	National Livestock Research Institute (Korea)
University of Queensland	Northern Pastoral Group: •Agforce (Queensland) •Australian Agricultural Company •Colonial Agricultural Company •Spicer Briggs Family Trust, "Cona Creek" •Consolidated Pastoral Company •J&SM Halberstater, "Mandalay" •S Kidman & Co •EA& G Maynard, "Mount Eugene" •GE&J McCarnley, "Tartrus" •MDH Pastoral Company •North Australian Pastoral Company •Stanbroke Pastoral Company
Victorian Department of Primary Industries	The Ohio State University (USA)
	SASTEK Pty Ltd
	WA Department of Agriculture

Mining CRC

Industry	University	Associate Member
Anglo Coal Australia	The University of Newcastle	The University of Arizona (USA)
AngloGold Ashanti	The University of Queensland	
BHP Billiton Innovation	The University of Sydney	
Caterpillar Elphinstone	Curtin University of Technology	
Hamersley Iron		
Komatsu Australia		
P&H MinePro Services		
Peabody Energy		
Phelps Dodge Corporation		
Rio Tinto		

Forestry CRC

Core Partners	Supporting Partners
CSIRO	Australian National University
Victorian Department of Sustainability and Environment	Tasmanian Department of Economic Development
Forest and Wood Products Research and Development Corporation	Forest Enterprises Australia Ltd
Forestry Tasmania	Forest Practices Authority of Tasmania
Forests and Forest Industry Council of Tasmania	Forest Products Commission of Western Australia
Great Southern Plantations Ltd	South Australian Forestry Corporation
Gunns Ltd	Hancock Victorian Plantations Pty Ltd
Hansol P I Pty Ltd	Integrated Tree Cropping Limited
Murdoch University	Midway Pty Ltd
Oji Paper Company Ltd	New South Wales Department of Primary Industries
Queensland Department of Primary Industries and Fisheries	Norske Skog Paper Mills (Australia) Ltd
Southern Cross University	South East Fibre Exports Pty Ltd
University of Melbourne	Southern Tree Breeding Association
University of Tasmania	Timbercorp Ltd
WA Plantation Resources Pty Ltd	

Vision CRC

Major Participants	Supporting Participants	Industry Participants
Centre for Eye Research Australia	Aboriginal Health and Medical Research Council	CIBA Vision (USA and International)
International Centre for Eyecare Education	Anglia Ruskin University, Department of Optometry and Ophthalmic Dispensing (UK)	Ellex Medical
Institute for Eye Research	Bascom Palmer Eye Institute (USA)	Essilor International
LV Prasad Eye Institute (India)	CSIRO Molecular Science	ProVision
	International Association of Contact Lens Educators	Vision Instruments
	Johns Hopkins University, Department of Ophthalmology (USA)	Australian Ophthalmic Consortium
	Optometric Vision Research Foundation	Contact Lens Industry Council
	Open Training and Education Network	
	Pennsylvania College of Optometry (USA)	
	Queensland University of Technology, Centre for Eye Research, School of Optometry	
	State Government of Victoria, Department of Human Services	
	University of California, Los Angeles, Jules Stein Eye Institute (USA)	
	University of Houston, College of Optometry (USA)	
	University of Sydney, Centre for Vision Research, Westmead Millennium Institute	
	University of Sydney, Save Sight Institute	
	University of Waterloo, Centre for Contact Lens Research (Canada)	
	Vision 2020: The Right to	

	Sight (Australia and Global)
	VisionCare NSW
	Zhongshan Ophthalmic Centre, Sun Yat-Sen University (China)
	Professor Antti Vannas (Finland)