Australian Government
Grains Research and Development Corporation

29 January 2010

Ms Maria Vamvakinou MP (Chair)
Standing Committee on Industry, Science and Innovation
PO Box 6021
House of Representatives
Parliament House
CANBERRA ACT 2600
Email: isi.reps@aph.gov.au

Dear Ms Vamvakinou,

The Grains Research and Development Corporation (GRDC) is pleased to provide this submission to the Standing Committee on Industry, Science and Innovation inquiry into Australia's international research collaboration. The GRDC is a statutory authority established to plan and invest in research, development and extension (RD&E) activities for the Australian grains industry. Its primary objective is to support effective competition by Australian grain growers in global grain markets, through enhanced profitability and environmental sustainability.

As a major investor in grains RD&E, the GRDC provides considerable support for international research collaboration in an effort to facilitate the exchange of research and development knowledge that can deliver benefits to the Australian grains industry. The reason is that, on a global scale, Australia is a small investor in grains and agricultural R&D so it must establish strong and productive relationships with international agricultural research centres and other R&D providers. Australia's geographic isolation also means that Australian scientists must be outward looking and prepared to engage with the rest of the world—and globalisation makes this even more imperative.

The 2008 Cutler Review of Australia's Innovation System (*Venturous Australia: Building Strength in Innovation*) also recognised the important contribution that international collaboration makes to Australia. The Cutler Review noted that since Australia represents just two percent of the world's knowledge-generating capacity, international collaboration is critically important for growing Australia's innovation capacity, enhancing participation in global knowledge networks, and increasing the impact of Australian research in the international arena (p.72 of *Venturous Australia*). These comments substantially address that part of term of reference (TOR) 3 that the GRDC wished to address—namely *the key drivers of international research collaboration at the institutional and researcher levels*. As a result, TOR 3 will not be addressed further in this submission.

TOR 1: The nature and extent of existing international research collaborations

Australia has a high level of self-sufficiency and is a strong export player, but as noted in the introduction to this submission, on a global scale Australia can still make significant gains by the astute leverage of international resources. The GRDC has acknowledged this through a continuous process of supporting and increasingly contributing to the management of key international collaborations with international agricultural research centres and other R&D providers on behalf of the Australian grains industry.

The extent of existing international research collaboration undertaken in GRDC program areas differs considerably depending on the need and opportunities for international collaboration in each area.

The GRDC's research portfolio is divided into the following program areas:

- pre-breeding
- wheat and barley breeding
- pulse, oilseed and summer coarse grain breeding
- crop protection
- agronomy, soils and environment
- climate change
- validation and integration
- extension and grower programs
- new grain products
- new farm products and services
- building research capacity
- corporate communication

Within these program areas, the GRDC supports international research collaboration in breeding (crop variety improvement); biotechnology; physiology; grain quality attributes; biosecurity; crop protection; beneficial soil microbes; crop sequencing; and agronomy to address the impacts of climate change. The GRDC also supports capacity building activities in the grains industry which provide opportunities for the international exchange of senior researchers, postdoctoral researchers and PhD students between Australian and overseas universities and agricultural research centres. In general terms, international research collaboration is greatest in GRDC program areas associated with plant breeding, biosecurity and agronomy, and occurs to a lesser extent in efforts to bring new farm products and services to Australia which are already used successfully overseas.

Specific examples of international research collaborations in GRDC program areas and some of the benefits they deliver to Australia are listed below. Further benefits to Australia from GRDC-supported international collaborations are demonstrated in a series of case studies presented under TOR 2 in the submission.

1.1 Access to international germplasm from CIMMYT, ICARDA and ICRISAT

Australia is a net importer of the base germplasm that underpins development of improved varieties of grain crops, since it possesses few indigenous plant species related to Australia's primary grain crops. Consequently, maintaining collaborations with key international research centres is essential to ensuring that Australian plant breeders are able to obtain the genetic material and associated international knowledge necessary to produce superior varieties.

The GRDC is one of 64 member organisations that continue to support international agricultural research centres that operate under an umbrella organisation, the Consultative Group on International Agricultural Research (CGIAR). As part of its commitment to CGIAR, the GRDC continues to supports valuable interactions with the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico and the International Centre for Agricultural Research in the Dry Areas (ICARDA) in Syria. The GRDC has established formal Strategic Alliances with CIMMYT and ICARDA, under which GRDC works with both organisations on a suite of research projects that benefit Australian grain growers as well as poor farmers in the developing world. Critically, these Alliance programs ensure that Australian plant breeders have long-term targeted access to international wheat, barley and pulse germplasm. In addition, Alliance agreements provide a framework for information sharing in accordance with the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

Under the Alliance programs, the GRDC funds strategic research projects at CIMMYT and ICARDA and supports Australian wheat and pulse breeders to travel to both organisations to select promising germplasm for further evaluation in Australia. These activities have facilitated the targeted importation of wheat and pulse breeding lines containing traits of interest to Australian breeders and pre-breeding researchers, including lines with improved drought and frost tolerance and enhanced disease resistance.

Based on the success of these Alliances, the GRDC is now progressing a similar Alliance with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and working to further strengthen the relationship with ICRISAT through Pulse Breeding Australia, specifically in areas of

genomics and pulse quality. Current peanut cultivars have been bred from elite drought-tolerant germplasm imported from India.

The establishment of targeted international alliances is well justified in light of the outcomes realised by the Australian grains industry. For example, it has been estimated that the spillover benefits from CIMMYT's research, aimed at developing countries but nevertheless valuable in Australia, are valued at an average of A$30 million per year (Brennan and Quade, 2006). This analysis has remained consistent over an extended time and is due to gains initially from semi-dwarf wheats, and subsequently from generally higher yielding varieties resistant to biotic and abiotic stresses.

A strategic review of the GRDC-CIMMYT Alliance, conducted in 2007, found that the Alliance has resulted in the delivery of novel germplasm of greater relevance to the Australian production environment, primarily through improved information exchange between CIMMYT and Australian wheat breeders and researchers. In addition, the Alliance has resulted in Australian breeders accessing elite CIMMYT germplasm 1 year before the germplasm is made available to other international breeders and researchers.

In addition, collaboration with international centres has resulted in major advances in areas other than germplasm introduction, such as increased availability of expert technical services at a much lower cost than is possible in Australia. ICARDA may also be used as an off-season screening site for Australian breeding material. Collaboration with ICARDA has resulted in major advances in the development of virus resistant pulses, as shown in Case Study 1 on pages 6-7 of this submission.

1.2 International collaboration to bring soil inoculant technology to Australia

An example of how international collaboration is helping to bring new farm products and services to Australia is Novozymes Biologicals Australia Pty Ltd, a joint venture between the GRDC and Novozymes Biologicals Ltd in Canada that was established to bring soil inoculant technology from Canada and North America to the Australian market.

The GRDC has invested approximately $20 million over a five year period—in more than 30 projects across a dozen organisations—seeking to develop both management solutions and new soil inoculant products. The purpose is to increase plant productivity through both suppressing soil-borne disease and promoting plant growth.

This work involved undertaking detailed investigations into the optimum way to commercialise this technology, including by:

- bundling together the research outputs arising from numerous research projects owned jointly by the GRDC and other research providers;
- seeking access to manufacturing and delivery technology and manufacturing capacity from both Australian and overseas companies; and
- seeking access to new inoculant technologies, from overseas sources, that may be useful to Australian growers—subject to Australian importation and product registration requirements.

Two new soil inoculant products have been developed from the research—TagTeam®, a dual-action inoculant for legumes; and Jumpstart®, a single-action inoculant for cereals, pulses and oilseeds. Both products address phosphate fertility by containing the naturally-occurring, phosphorous-solubilising soil fungus *Penicillium bilaii*, which forms a mutually beneficial relationship with plants as seeds germinate and develop roots. The fungus, sourced from GRDC-supported research, unlocks phosphorous from the soil and makes it available for plant growth. The dual-action TagTeam addresses both phosphate and nitrogen fertility by combining the soil fungus *P. bilaii* with *Rhizobium* inoculants, naturally-occurring soil bacteria well known for their symbiotic, nitrogen-fixing relationship with legumes. Some of the earlier product development was enhanced by collaboration facilitated by GRDC between University of

Adelaide, Flinders University and the China Agricultural University under the GRDC's Soil Biology Initiative.

Two replicated trials with field peas on South Australia's Eyre Peninsula and in southern New South Wales at Marrar demonstrated that the dual-action TagTeam increased yield by 8 per cent over that achieved by a single *Rhizobium* inoculant. Meanwhile, 20 on-farm field trials using farmer equipment showed that using JumpStart and TagTeam allowed growers to reduce rates of phosphate fertiliser. Taking the cost of the treatment into consideration, this resulted in a return on investment of better than 3:1. There is certainly strong field evidence that *P.bilaii* application to crop seeds results in greater phosphate fertiliser conversion efficiency.

TagTeam was launched in Australia in early 2009 and is the first product commercialised by the joint venture. Jumpstart is awaiting final regulatory approval from the Australian Pesticides and Veterinary Medicines Authority (APVMA) and is expected to be released this year (2010). The response from the industry to this new technology is very encouraging for the future of beneficial microbes in agriculture.

1.3 International collaboration to increase wheat exports for high-value noodle production in Asia

GRDC has invested in a series of market-based collaborative R&D projects. The objective of these projects has been to quantify wheat quality requirements in new markets. The new knowledge developed through these collaborative programs will assist the Australian grains industry to increase the value of wheat exports by more effectively meeting future market requirements. The results can be used in the short term to more effectively differentiate current crop production and in the longer term to develop new wheat varieties with improved functionality. Wheat varieties with improved functionality will enable Australia to retain and expand higher value wheat markets.

Taiwan

Collaboration was established between a major Taiwanese food processing company, UniPresident Enterprises, and Australian researchers from BRI Australia and CSIRO Plant Industry. The project established key criteria to assist UniPresident in the selection of wheat to produce high quality instant noodles. A further benefit of this work was the demonstration that selected Australian wheat grades produced more desirable noodle quality than that supplied by US imports. Most importantly, the collaboration allowed the Taiwanese company to produce their own data to demonstrate this result. The timing of this project and additional collaborative research projects in Taiwan have been linked to increased imports of Australian wheat for the production of noodles in Taiwan. The potential noodle wheat market in Taiwan is for 500,000 tonnes per year and represents significant value for the Australian industry.

China

A new GRDC investment has established collaboration between COFCO—which is responsible for purchases of Chinese wheat imports and the largest flour milling company in China—and wheat research company BRI Australia. The new collaboration will address the impact of blending Australian and Chinese wheat in order to supply the emerging demand for high-value food products in China. There are adequate quantities of wheat in China, however the quality is unsuitable for the production of high-end food products. By blending with selected Australian wheat it may be possible to use the Chinese wheat more effectively. A successful blending result will provide benefits to China and Australia. China will be better able to meet internal demand without total reliance on imports, while Australia can supply higher value wheat on a more consistent basis to what is a rapidly expanding market for higher value food products in China.

1.4 Other collaborations

Other examples of GRDC-supported international collaboration in grains R&D include:

- assisting with implementation on the International Treaty on Plant Genetic Resources for Food and Agriculture. The Treaty aims to provide for the conservation and sustainable use of plant genetic resources for food and agriculture. Australia is a signatory to the Treaty and benefits in accessing germplasm under the Treaty. The GRDC is assisting DAFF and the Treaty's Secretariat, by making staff available to provide technical advice on the Treaty's Standard Material Transfer Agreement and Multilateral System for access and benefit sharing.
- financial support for the Global Crop Diversity Trust—the GRDC has a commitment for US$5 million over a five year period. The trust exists to provide a permanent source of funds to support the long-term conservation of germplasm on which the world depends for food security.
- expanded network of international collaborations with both private and public sector organisations—for example, as a partner in the international effort to combat the spread of the Ug99 stem rust pathogen, the GRDC now participates in several projects funded by the Bill & Melinda Gates Foundation.
- continued support for a collaborative project with the Australian Centre for International Agricultural Research (ACIAR) with the overall aim of using germplasm with improved yield, quality, disease resistance and agronomic characteristics from China, India and Australia to enhance productivity of canola-quality *Brassica napus* and *B. juncea* in all three countries. The project is in line with both the ACIAR's objective of assisting developing countries to improve skills and resources, and the GRDC's objective of enhancing oilseed brassica production in Australia. The project involves 13 institutes across the three countries.
- a GRDC-funded research collaboration between the Department of Agriculture and Food Western Australia, the Tasmanian Institute of Agricultural Research and seven Chinese research institutions—to provide Australia with access to novel barley germplasm with improved tolerance to environmental stress factors such as acid soil, waterlogging, drought, frost and salinity. The initial germplasm screening activity will take place at various locations in China before a small selection of barley germplasm will be introduced to Australia. The Chinese research collaborators are based at Zhejiang University, Yangzhou University, Hua Zhong Agricultural University, Zhejiang Academy of Agricultural Sciences, Tibetan Academy of Agricultural Sciences, Xingjinag Shihezhi Agricultural University and Yangtze University.
- participating in a program with Grasslanz Technology Ltd, a commercial venture of a New Zealand Crown Research Institute, AgResearch, to identify and develop cereal endophytes (beneficial microbes) that may have a role in controlling heat and water stress and insect damage in cereals. Grasslanz is a world leader in endophyte technology and has been responsible for bringing insect-resistant pastures containing endophytes to market in Australia and the United States. To assist in this work, AgResearch was also successful in obtaining significant funding from the New Zealand Foundation for Research, Science and Technology.
- collaborative work with New Zealand on using agronomy to address the impacts of climate change.
- supporting complementary work on pulse molecular markers with international collaborators, including the University of Saskatchewan, Canada, and a Chinese consortium.
- funding research visits to key international markets, student exchanges and opportunities for the R&D community to understand and respond to changing market requirements.
- GRDC in partnership with the University of Lancaster and the University of Adelaide are developing a new soil test for phosphorus using diffuse gradients through thin films technologies.
- GRDC in partnership with Soil Essentials, a Scottish Precision Agriculture consultancy firm, provides sensor equipment and data analysis services to Australian advisors and grower groups. A number of agriculture advisors have visited Canada and the USA to discuss and pick up on the latest precision agriculture technologies.
- GRDC in partnership with the Conservation Agriculture Association of Australia and New Zealand (CAAANZ) has facilitated bilateral visits with North and South American scientists and farmers focussing on improving conservation farming and no-till cropping systems.
- GRDC facilitates the involvement of the Foundation for Arable Research (FAR) in New Zealand in canopy management projects in Australia and provides training to advisors and growers.

- The GRDC-supported Managing Climate Variability Program has a project working specifically with the Hadley Centre in the British Meteorological Office on exploring historical climate records.

1.5 International delegations

The GRDC also hosts international delegations from countries with well-established grains industries. Through such visits, the delegations learn about Australia's industry–government collaborative approach to R&D, while the GRDC gathers first-hand information about the industry drivers in other countries.

High-level visits of particular note over the past two years include those of:

- Dr Mahmoud Solh, Director General of ICARDA, and his assistant Mr Scott Christiansen, in August 2007
- Dr Mathew Abang, a pulse pathologist from ICARDA, in October 2007
- a 25-member delegation from the Asociación de Cooperativas Argentinas, Argentina, in November 2007
- a 14-member delegation from Anhui Provincial Grains Bureau, China, in November 2007
- Dr Ali Hussein Kodhim-al-Behadli, Iraqi Agriculture Minister, in January 2008
- a three-person delegation from Agriculture Research Division, Alberta Agriculture and Food, Canada, in February 2008
- an eight-person delegation from Alberta Crop Industry Development Fund Ltd, Canada, in February 2008
- a five-person delegation from the Ministry of Agriculture, China, in April 2008
- Dr Katherine Kahn, Program Officer of the Agricultural Development Initiative at the Bill and Melinda Gates Foundation, in August 2008
- Dr Cary Fowler, Executive Director of the Global Crop Diversity Trust, in September 2008
- Dr Thomas Lumpkin, Director General, and Peter Ninnes, Executive Officer—Research Management, of the CIMMYT, in September 2008
- a four-person delegation from Kazakhstani Trade and Agriculture, in September 2008
- a five-person delegation from the Japan Flour Millers' Association, in September 2008
- a 25-member delegation from the Association of Argentine Cooperatives, in November 2008
- a five-person delegation from Groupe Limagrain of France, in November 2008
- an 18-member delegation from China's State Administration of Grain, in December 2008
- Dr Dyno Keatinge, Director General of the World Vegetable Centre, in December 2008
- Professor Philip Pardey, Professor of Science and Technology Policy in the Department of Applied Economics at the University of Minnesota, in February 2009
- Dr Prem Warrior, Senior Program Officer - Agricultural Development at the Bill and Melinda Gates Foundation, in April 2009.

TOR2: The benefits to Australia from engaging in international research collaborations

The sustainability of Australian agriculture relies heavily on continued access to new sources of genetic material, or germplasm, imported from other countries to enable Australian plant breeders to breed or select new, improved cultivars of crops and pasture plants. Specific examples of how GRDC-supported international research collaborations with international agricultural research centres and other R&D providers have delivered benefits to Australia are presented in the case studies below.

2.1 Case study 1 – International collaboration delivers chickpeas with fungus resistance

Prior to the emergence of ascochyta blight in Australia in 1996, Australia's chickpea industry was expanding rapidly. However, as none of the varieties available at that time had any resistance to the disease, ascochyta blight led to the steady decline in chickpea production across Australia (Figure 1).

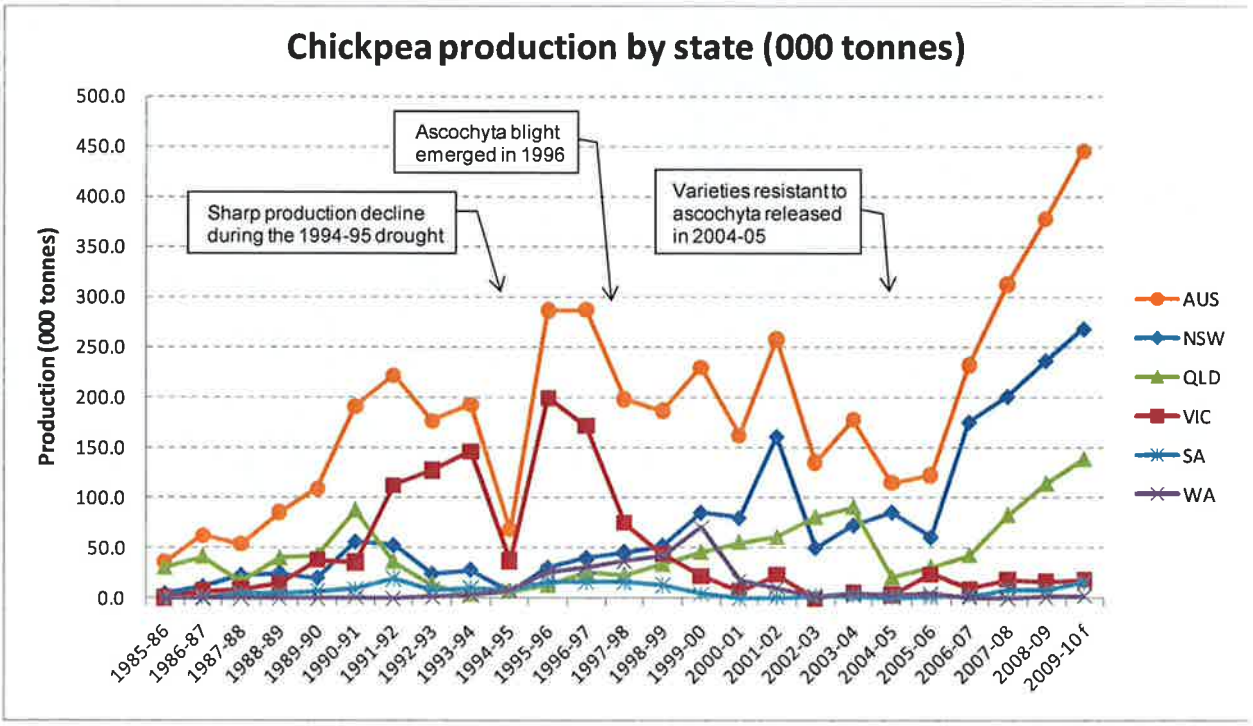

Figure 1. Chickpea production in Australia over the past 25 years, showing the impact of ascochyta blight and the industry's resurgence after disease-resistant varieties were released in 2004-05.

The emergence of the disease required a major shift in emphasis by the agencies involved in chickpea research. A number of strategies were employed to combat ascochyta blight. One was the development of a management package to minimise the impact of the disease. Another was the screening of a large number of chickpea lines in Turkey and at ICARDA (the International Centre for Agricultural Research in the Dry Areas) in Syria, for resistance to the disease.

At the same time, the breeders made specific crosses for ascochyta blight resistance. These were assessed in their disease nurseries and the best lines were rapidly advanced by single-seed descent. The first variety with improved resistance, *Howzat*, was released in 2002, but it was useful only as an interim measure to sustain the industry.

As a result of the determined efforts of breeders in Australia's state-based pulse breeding programs, a number of new varieties with greatly improved ascochyta blight resistance and good seed quality were released in 2005. The new varieties *Genesis*, from the Victorian Department of Primary Industries program, and *93011-1021* from the NSW Department of Primary Industries program were released in the southern cropping region. Both varieties have significantly improved resistance to ascochyta blight, and have contributed to a steady resurgence in Australian chickpea production since their release.

GRDC subsequently established Pulse Breeding Australia (PBA) in March 2007 to provide national coordination of Australia's pulse breeding programs. PBA is a collaborative venture between the GRDC, Pulse Australia, the University of Adelaide, the SA Research and Development Institute (SARDI) and state departments of primary industries in Victoria, NSW, Queensland and Western Australia. ICARDA remains an important international research partner for PBA's breeding and germplasm enhancement programs. Last year, ICARDA tested pulse varieties, breeding lines and germplasm accessions from Australia for resistance against three major viruses. Such assistance from ICARDA in developing diagnostic tests and reliable techniques for screening Australian breeding material against exotic diseases and pathogens has been essential for improving virus resistance in Australian pulse varieties for many years.

Figure 2. Research trial of an older variety Gully(1) (left) and the newly released chickpea variety PBA HatTrick(1) (right) clearly showing the superior performance of HatTrick(1) under high ascochyta blight disease pressure.

To date, PBA has released five varieties of chickpeas and lentils. New PBA varieties such as the desi chickpea HatTrick(1) significantly increase growers' gross margins by vastly reducing or eliminating the need to use fungicide sprays against ascochyta blight disease. These new strains also provide increased resistance to phytophthora root rot, as well as higher yield and better seed quality. Figure 2 illustrates the difference in performance between the old variety Gully(1) and the new variety HatTrick(1) under high disease pressure from ascochyta blight.

The Australian Bureau of Agricultural and Resource Economics (ABARE) chickpea production forecast for Australia this season (2009-10) is around 425 to 450 thousand tonnes, up from around 378,000 tonnes in 2008-09. This clearly shows that the industry is bouncing back strongly and now producing 3-4 times more grain than the 115,000 tonnes achieved in 2004-05 when the new disease-resistant varieties were first released.

2.2 Case study 2 – International collaboration to develop rust-proof wheat

The Australian Cereal Rust Control Program (ACRCP) draws together expertise and resources from the University of Sydney Plant Breeding Institute at Cobbitty (PBIC) in New South Wales, the CSIRO Division of Plant Industry in Canberra, the University of Adelaide, and the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico. The ACRCP is internationally recognised for its ability to discover and use novel sources of rust resistance from wild relatives of wheat.

The University of Sydney has had a long involvement in cereal rust research, spanning some 80 years. Early work at the university clearly demonstrated that sustained control of cereal rusts could be achieved only with a nationally coordinated approach. The current rust team at the PBIC works on 13 different rust diseases. The PBIC is responsible for monitoring the rust pathogens throughout Australia; is involved in research to identify, characterise and incorporate new sources of rust resistance in all cereal crops; and interacts closely with Australian cereal-breeding programs to ensure that the resistances identified find their way into new varieties.

A recent study by Murray and Brennan (2009a, 2009b) estimated the current average annual losses due to various rust diseases in wheat and barley to be $177 million with potential losses of up to $1.8 billion. It is estimated that breeding for rust resistance annually contributes to $1.09 billion in savings to the grains industry. Continued access to new germplasm from CIMMYT greatly enhances the capability of Australian wheat-breeding programs to develop cultivars with durable rust resistance. Over the past two decades, CIMMYT's rust resistance program has developed an understanding of the genetic basis of this

resistance, by identifying, mapping and designating resistance genes. This information has in turn assisted wheat breeders in selecting for such resistances.

The ACRCP formally became a partner in the Borlaug Global Rust Initiative during 2008–09. This means that the Australian research effort is now fully integrated with the international fight to control the spread of the Ug99 stem rust pathogen.

In 2009, ACRCP partner CSIRO continued work to develop genetic markers for Ug99 stem rust resistance genes that will permit more efficient deployment of the genes in new Australian wheat varieties as a pre-emptive measure against any possible incursion. A highlight of the ACRCP's work last year was the publication of a paper in the international journal *Science* by CSIRO researchers and their collaborators at the University of Zurich (Switzerland), who identified the gene and predicted protein product of Lr34/Yr18. This scientific breakthrough provides valuable insight into the mechanics of durable rust resistance against Ug99 and also provides perfect molecular markers for use in associated breeding activities.

2.3 Case study 3 – International collaboration on biosecurity to protect Australia and its markets

In one area of research to pre-empt possible pest incursion, the GRDC has invested in an international pre-breeding program to provide Russian wheat aphid resistance in wheat and barley. The nine countries involved are Australia, USA, United Kingdom, France, Syria, Turkey, South Africa, Kenya and Argentina. The research is intended to pre-empt a possible incursion of the Russian wheat aphid, which has the potential to cause 70 percent yield loss in cereal crops and is present on every continent except Australia (see Figure 3). The program has discovered the mechanism that allows Russian wheat aphid to quickly develop virulence to resistant plants without associated declines in overall fitness, despite the aphid's asexual mode of reproduction. This information provides cereal breeders with essential knowledge for pyramiding genes for durable resistance.

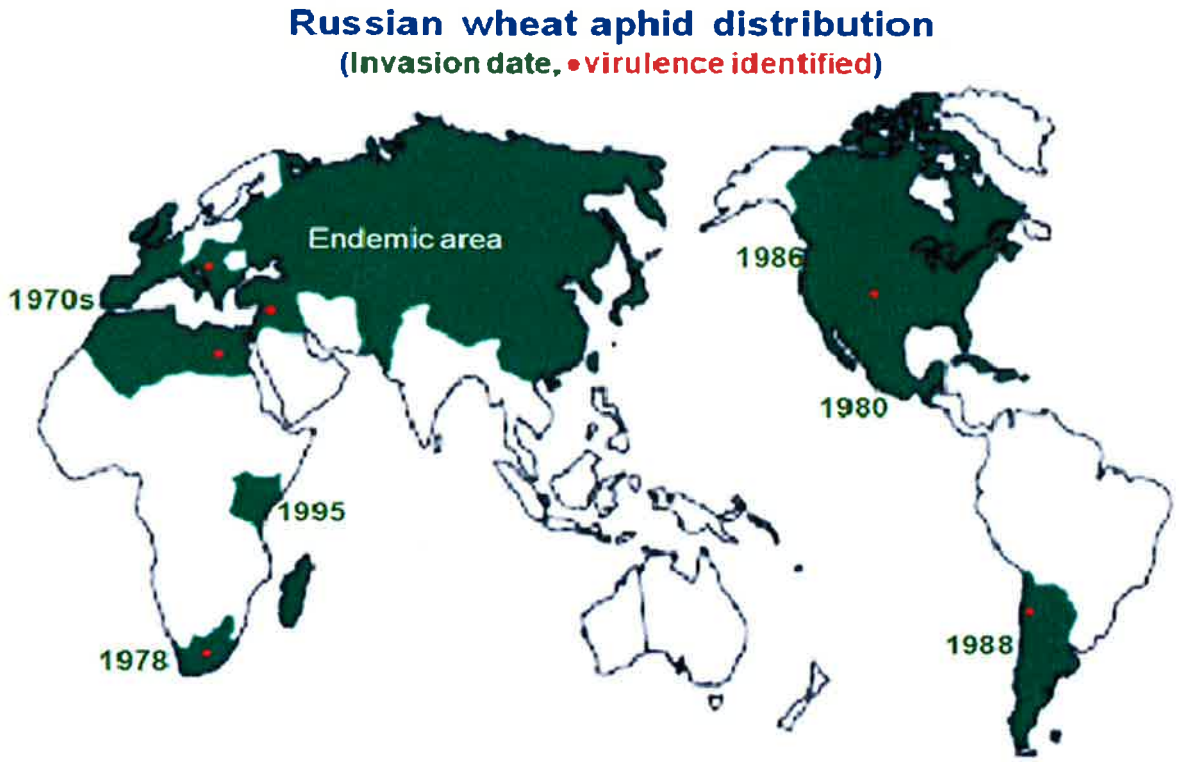

Figure 3. The global distribution of Russian wheat aphid.

In another area of research to pre-empt possible pest incursion, the GRDC is a significant co-investor in Australia's National Grains Industry Biosecurity Plan. This plan is developed and updated by Plant Health Australia in partnership with the GRDC, the GCA, the state and territory governments and the Australian Government. The current Biosecurity Plan for the grains industry, launched in 2008–09, provides the framework and summarises the responsibilities for managing biosecurity threats. It also includes internationally recognised protocols for identifying and managing pest outbreaks.

An example of how biosecurity threats are managed occurred in 2004 when PHA's Biosecurity Plan was put into action to defend Australian trade when a damaging claim was made against a shipment of wheat to Pakistan. Threat summary tables had been prepared for the 14 highest value grain crops in Australia, prioritising the major pest and disease threats for each crop and identifying required management actions. In response to the claim that the wheat shipment was contaminated with Karnal bunt, the internationally accepted diagnostic protocols developed for the grains biosecurity plan clearly demonstrated that there was no Karnal bunt in Australia. Within days, appropriately trained people were able to investigate the claim and conduct laboratory tests, resulting in a clean bill of health for the shipment.

The CRC for National Plant Biosecurity has since developed an enhanced protocol for the extraction of DNA from grain dust spores of *Tillietia indica*, the cause of Karnal bunt in wheat. This protocol has been used in an international test for validation and to enhance detection methods.

2.4 Case study 4 – Increasing wheat production in high-rainfall zones

GRDC-supported research is seeking to increase the area sown to high-quality milling wheat in Australia's high-rainfall zones, using the best available germplasm from comparable regions in the northern hemisphere. The aim is to make use of sustained soil moisture levels, and reach the higher average yields that can be achieved in these regions.

One Australia–New Zealand alliance, HRZ Wheats Pty Ltd, is targeting the high-rainfall areas of the southern tablelands and slopes of New South Wales, western Victoria and southern Western Australia. HRZ Wheats is a joint venture between CSIRO, the New Zealand Institute for Plant and Food Research and the GRDC. Many northern hemisphere breeding programs use New Zealand as an out-of-season facility for seed increase, and the alliance aims to capitalise on this access to overseas material. A quarantine centre has been established near Canberra so that elite overseas lines can be imported within months of their harvest in New Zealand.

The move to strengthen production in high-rainfall areas was pioneered over a decade ago through the introduction of dual-purpose winter wheats. Further breeding for disease resistance and quality attributes is another essential part of ensuring that Australian wheat production will be able to reliably meet the demands of future markets. The alliance is delivering high-yielding, disease-resistant, milling-quality wheat varieties for Australia's high rainfall zones—HRZ Wheats released the new variety Gascoigne(1) last year (2008-09)—and has the potential to bring three million hectares of higher rainfall country into grain production.

2.5 Case study 5 – Enhancing grain resistance to pre-harvest sprouting

Pre-harvest sprouting of grain periodically results in large financial losses to Australia's grains industry due to downgraded quality when rain falls during or very close to harvest. Although dormancy is a common mechanism to prevent seeds from germinating immediately if they get wet, this trait has been bred out of most Australian wheat varieties, leaving the grain vulnerable to pre-harvest sprouting in wet conditions. Some wheat varieties are more susceptible than others to sprouting in the field. For example, Westonia(1) is extremely susceptible, whereas Janz and Spear are classed as 'susceptible' and 'moderately tolerant' respectively.

Researchers in Adelaide tested hundreds of lines for their ability to tolerate pre-harvest sprouting conditions and found an old South African-bred wheat with the desired characteristics among seed from a

GRDC-supported Winter Cereals Collection at Tamworth, New South Wales. Its high level of tolerance was subsequently demonstrated under field conditions.

Wheat breeders in northern New South Wales and Queensland began incorporating this dormancy trait into their programs several years ago. More recently, breeders in other parts of Australia and overseas have taken up the challenge—with long-term support from growers, delivered through the GRDC—and crosses have progressed to advanced stages of development. This means that new wheat varieties that are tolerant of conditions that usually lead to pre-harvest sprouting should soon be available.

TOR 4: The impediments faced by Australian researchers when initiating and participating in international research collaborations and practical measures for addressing these

The GRDC does not wish to address TOR 4 as it can be more directly answered by researchers.

TOR 5: Principles and strategies for supporting international research engagement

The GRDC's primary objective is to support effective competition by Australian grain growers in global grain markets, through enhanced profitability and environmental sustainability. The GRDC has adopted four corporate strategies to drive the corporation's R&D investments to achieve the greatest benefits for the grains industry and the wider community. The GRDC's four corporate strategies are to:

- Coordinate a national grains R&D agenda and portfolio
- Deliver against Australian Government priorities
- Grow and leverage total grains R&D investment
- Ensure R&D is market driven.

An important principle for the GRDC in relation to supporting international research engagement is to ensure that such efforts are consistent with the GRDC's corporate objectives and strategies.

Australia must continue to engage globally to facilitate the exchange of research and development knowledge that can deliver benefits to Australia, given Australia's geographic isolation and small market size on a global scale. As noted in the introduction to this submission, the 2008 Cutler Review of Australia's Innovation System recognised the important contribution that international collaboration makes to Australia. The Cutler Review noted that since Australia represents just two percent of the world's knowledge-generating capacity, international collaboration is critically important for growing Australia's innovation capacity, enhancing participation in global knowledge networks, and increasing the impact of Australian research in the international arena. Economic analysis by Mullen and Crean (2007) has also shown that R&D undertaken overseas makes an important contribution to both productivity growth and the gross value of production in Australian agriculture, as shown in Figure 4 below.

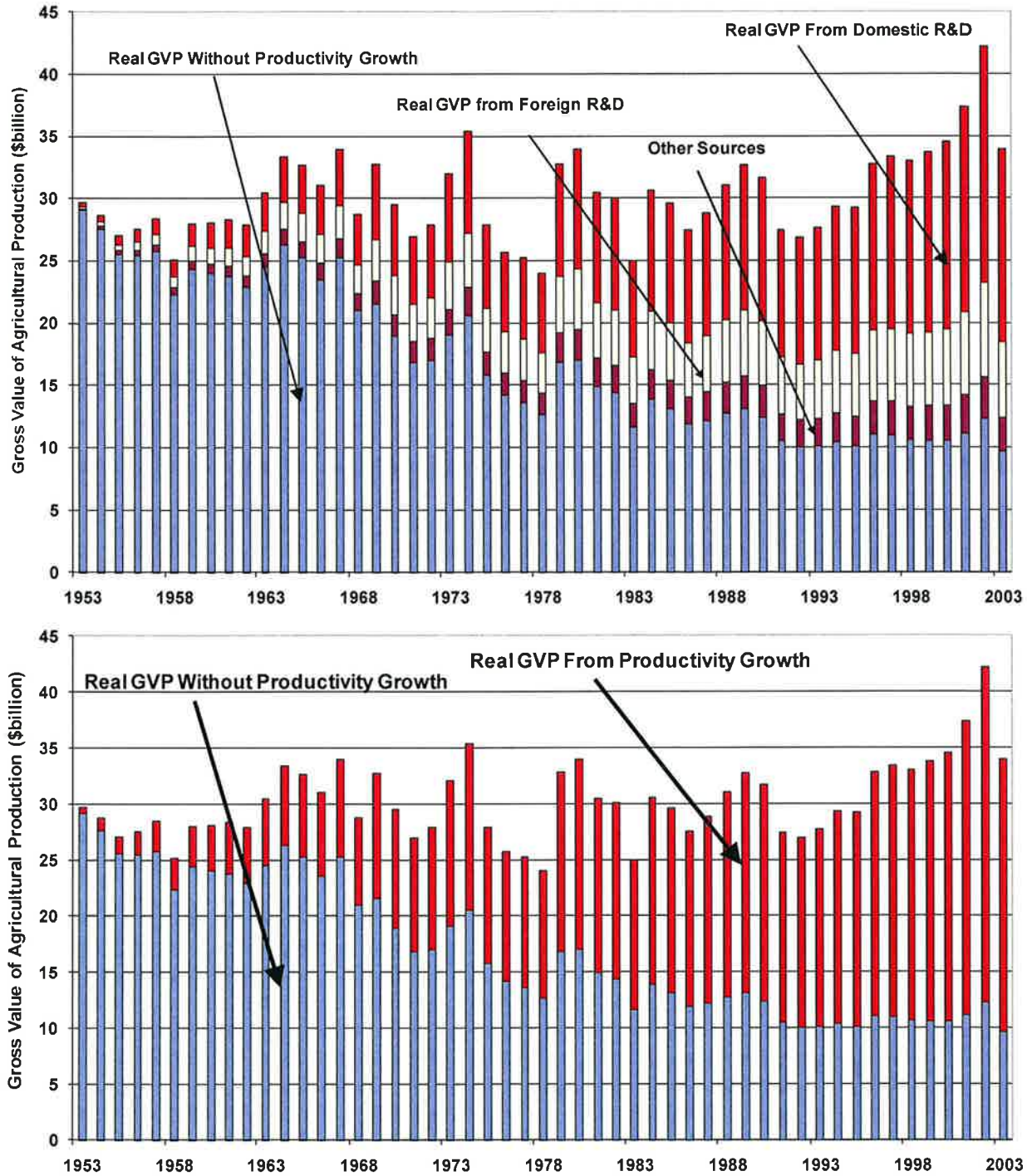

Figure 4. The contribution of Australian and international R&D (top) and productivity growth (bottom) to the gross value of production (GVP) in Australian Agriculture. Source: Mullen and Crean (2007).

In GRDC's experience, successful collaboration is underpinned by:

1. Alignment of interests between the collaborating parties
2. Setting clear expectations about the purpose of the collaborations and the desired outputs
3. Track record in delivery
4. Quality science (this can also be aided by the collaborating party/ies having made significant contributions into the public domain)

5. Building multi-level relationships between the collaborating organisations (relationships between those at the bench, field, management personnel and CEO/executive level personnel)
6. Understanding the policy support provided in the collaborators' countries.

There are many different aspects of the innovation system that assist GRDC to find and engage meaningfully with potential collaborators, including:

1. Australia's reputation and track record in R&D, largely built over the years through public funding of research
2. Our ability to support scientific exchanges (conferences, travel awards, PhD scholarships etc.) so that personal relationships are developed between researchers in different countries
3. Our ability to invest cash into R&D projects
4. Our ability to invest to ensure technology is made available to Australian growers even if the Australian market is not particularly attractive to the technology owners/developers
5. Intellectual Property protection, particularly plant breeders rights and the value capture system that has created (elaborated on further below)
6. Resilience and creativity of the Australian grains industry in fighting to remain competitive.

Increasingly in developed countries R&D is being conducted through private investment, particularly by the life bioscience companies. The potential of biotechnology to drive productivity improvements in the grains industry will create opportunities for overseas investment (for example, life bioscience company investment in strategic and applied R&D in Australia). Australia must (and is) finding ways to tap into this privately-held knowledge and technology using a number of different approaches.

Investment by international organisations in the Australian grains industry has been growing in recent years. For example, there is now an alliance between CSIRO and Bayer Crop Science; the Australian-based wheat breeding company LongReach Plant Breeders is owned by Syngenta and Pacific Seeds (a subsidiary of United Phosphorus Limited); and Limagrain though Vilmorin & Cie has invested into Australian wheat breeding company Australian Grain Technologies (AGT). This investment provides opportunities for knowledge and technology exchange.

For its part, the GRDC will continue to engage globally by supporting and contributing to the management of key international collaborations and seeking to attract private capital to grains industry R&D in Australia where possible.

The GRDC will also continue to support capacity building activities in the grains industry which provide opportunities for the international exchange of senior researchers, postdoctoral researchers and PhD students between Australian and overseas universities and agricultural research centres.

The GRDC would be pleased to discuss any issues you may wish to raise about this submission or any other matter regarding international collaboration in grains R&D. If you would like to hold further discussions with the GRDC, please contact Ms Leecia Angus, Executive Manager Corporate Strategy and Impact Assessment, on (02) 6166 4521 or email L.angus@grdc.com.au.

I look forward to seeing the final report when it is released.

Yours sincerely

PETER F. READING
Managing Director

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TERMS OF REFERENCE

The House of Representatives Standing Committee on Industry, Science and Innovation shall inquire into and report on Australia's international research engagement, with particular reference to:

1. The nature and extent of existing international research collaborations.
2. The benefits to Australia from engaging in international research collaborations.
3. The key drivers of international research collaboration at the government, institutional and researcher levels.
4. The impediments faced by Australian researchers when initiating and participating in international research collaborations and practical measures for addressing these.
5. Principles and strategies for supporting international research engagement.

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For the 42nd Parliament the Committee is comprised of ten Members of the House of Representatives, with six Members nominated by the Government and four nominated by the non-Government parties.

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